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**PERFORMANCE ENHANCEMENT IN E-COMMERCE THROUGH THE ADOPTION
OF BIG DATA ANALYTICS**

Ishan Shekhar

Research Scholar, Department, (School of Management and Commerce), Vikrant University,
Gwalior, (M.P)

Dr. Sapna Rathore

Professor Department, (School of Management and Commerce), Vikrant University, Gwalior,
(M.P)

ABSTRACT

More sophisticated analytical techniques are required to enhance inventory management efficiency and price accuracy due to the accelerated expansion of online commerce. Using a quantitative research technique, this study investigates how Big Data Analytics (BDA) affects inventory management practices and dynamic pricing in e-commerce firms. Structured questionnaires were sent out to 30 managers and decision-makers from chosen e-commerce companies that had used BDA in order to gather primary data. Substantial decreases in stockouts and surplus inventory, as well as marked improvements in pricing accuracy and inventory efficiency, were seen following the adoption of BDA, according to the results. The research proves that e-commerce companies greatly benefit from Big Data Analytics in terms of data-driven decision-making and operational effectiveness. Insights for e-commerce companies looking to enhance pricing and inventory strategies using Big Data Analytics are offered by the research, which also adds to the expanding body of literature on analytics-driven retail management.

Keywords: Big Data Analytics, E-Commerce, Consumer, Inventory, Pricing

I. INTRODUCTION

Nowadays, companies run their operations differently, especially those involved in online commerce, thanks to the introduction of big data in the modern digital age. The exponential growth of the internet and other related technologies have propelled electronic commerce, or "e-commerce," from its humble beginnings as an alternate means of purchasing products and services to its current position as the preeminent marketplace on a worldwide scale. The proliferation of digital transactions has resulted in an explosion of data generated by a wide variety of sources, including as interactions with customers, online purchases, social media, mobile apps, and IoT devices. Big data describes this massive collection of data that includes both organized and unstructured information. Big data is all about the quantity, variety, velocity, validity, and value of data, which are also referred to as the "5 Vs" of big data. From these angles, we can see the possibilities and threats that come with using data to make smart decisions about e-commerce strategy, operations, and growth.

Businesses now have more opportunity than ever Pre to monitor consumer behavior, forecast trends, customize experiences, and improve supply chains thanks to the integration of big data into e-commerce. In order to make judgments, traditional business models on intuition and historical data, which were not always accurate or flexible enough for today's fast-paced markets. However, with big data, companies can analyze customer preferences, buying habits, web surfing habits, and engagement metrics in real-time, which helps them create more personalized marketing campaigns and product suggestions. For example, to increase sales and customer happiness, e-commerce giants like Amazon, Alibaba, and Flipkart utilize advanced big data analytics technologies to monitor user actions, examine clickstreams, and forecast what customers will buy next. Companies may improve the shopping experience for customers by looking at detailed information including search history, demographics, geographical data, and past purchases. This helps with demand forecasting, product placement optimization, and creating targeted offers.

In addition to providing valuable insights into customers, big data analytics in e-commerce also helps improve operational efficiency and supply chain management. The use of predictive analytics may substantially simplify the logistical challenges faced by e-commerce companies, particularly those pertaining to inventory management, order fulfillment, and delivery

optimization. For better demand forecasting, fewer stockouts, and less excess inventory, businesses should examine real-time inventory levels, sales data from the past, and changes in demand across the seasons. In addition to improving the company's image, this data-driven strategy cuts operating expenses and guarantees on-time delivery to consumers. Big data also allows for dynamic pricing methods, which help companies stay competitive and maximize profits by adjusting product prices in real-time depending on market trends, competition pricing, and customer behavior.

Improving CRM and engagement tactics are two other areas where big data is making a splash in e-commerce. Personalized, frictionless, and efficient purchasing experiences across all platforms are what modern customers demand. Through the use of big data analytics, consumers may be divided into several groups according to their tastes, buying habits, and interaction patterns. This allows for more precise targeting of messages and more tailored promotions. Machine learning-driven recommendation engines, for instance, look at users' purchase and browsing histories to provide appropriate product suggestions, which in turn increases the likelihood of upselling and cross-selling. Brands may respond promptly to concerns, enhance service quality, and establish long-term loyalty with the use of social media analytics, customer reviews, and sentiment analysis, which give further insights into consumer attitudes. If e-commerce platforms combine big data with CRM systems, they can see the consumer from every angle, which will increase satisfaction and encourage repeat purchases.

Another crucial area where big data is essential in e-commerce is security and fraud detection. Payment fraud, account hacking, and identity theft are just some of the cybersecurity dangers that have emerged in tandem with the expansion of online transactions. By keeping tabs on user activity, login attempts, and transaction data in real-time, big data analytics can spot irregularities that might be signs of fraud. Rapid intervention and mitigation of any financial losses are made possible by machine learning algorithms' ability to detect suspicious actions in real-time. Sustaining development in the competitive e-commerce industry requires firms to take proactive security steps, protect consumer information, and retain trust in their online platforms. Data-driven risk assessment enables this.

More general marketing and strategic considerations are prompted by the use of big data in online

commerce. Market research, competitive landscape analysis, and trend identification are all made easier when companies have access to large data sets. Product launches, global growth, and promotional efforts are just a few examples of how firms may use predictive and prescriptive analytics to make well-informed strategic decisions. Furthermore, organizations may focus on high-value groups and allocate resources efficiently with the help of big data's insights into customer lifetime value (CLV). In order to improve their product offers, marketing budgets, and overall profitability, e-commerce enterprises can use advanced analytics techniques like sentiment analysis, clustering, and regression analysis.

Although big data has the ability to revolutionize e-commerce, there are a number of obstacles to its widespread use. Good infrastructure, advanced analytics tools, and trained data scientists are necessary to manage massive amounts of diverse data. Amidst the implementation of regulations like the General Data Protection Regulation (GDPR) and the Personal Data Protection Act in India, data privacy and regulatory compliance have become crucial considerations. In order to keep customers' confidence and stay out of legal trouble, businesses must use ethical data gathering, storage, and usage procedures. In addition, data must be accurate and of high quality; wrong insights, ill-informed judgments, and monetary losses can result from data that is either incomplete or of low quality. Companies should put money into data governance systems, cleansing procedures, and validation tools if they want to get the most out of big data analytics.

II. REVIEW OF LITERATURE

Kodadi, Sharadha. (2022) In this study, TF-IDF, a bottom-up method for product mapping, is employed to explore how big data analytics and new methodologies might be applied to e-commerce. Despite academic attention traditionally being focused on large merchants and manufacturers, small and medium-sized enterprises (SMEs) continue to be understudied. Since SMEs have grown in prominence, particularly Post the COVID-19 pandemic, a comprehensive analysis of product maps is necessary to understand product connections, complementarity, and competitive dynamics. Using crowd intelligence from e-commerce sites of small and medium-sized enterprises (SMEs), this article proposes the production of detailed product maps. Using data collected from over 52 SME sites, which provide details on over 90,000 commodities, the study uses TF-IDF to determine the word importance in product titles and descriptions. Cosine similarity

metrics, when used to construct a product map, reveal community hierarchies. Findings reveal competitive dynamics and aid SMEs in making price, product offering, and marketing strategy decisions by showing that goods on the same website frequently generate diverse communities. The study highlights the need of advanced N-gram and other natural language processing approaches for better text discriminating accuracy. The study gap in this area is brought to light by stressing the decentralized and heterogeneous character of SME e-commerce data. This study not only addresses these knowledge gaps in the e-commerce literature, but it also gives small and medium-sized enterprises (SMEs) valuable insights that may help them improve their business strategy. Research in the future should look into the method's applicability across many industries, incorporate real-time analytics, and increase the variety of data sources in order to help small and medium-sized enterprises (SMEs) adapt to and thrive in the ever-changing digital economy.

Mahmud, Md et al., (2021) Through its ability to optimize company operations and improve consumer experience, big data analytics has shook up the e-commerce sector. In this thesis, we look at how big data analytics has changed e-commerce platforms in many ways, including how it has helped businesses gain an edge through more personalised interactions with customers and more efficient internal processes. In this study, we use case studies and empirical data to explore how e-commerce companies may use big data to learn about their customers, make predictions about their purchases, and personalize their marketing campaigns. The research also looks at how supply chain efficiency, pricing tactics, and inventory management may be improved with data-driven insights. A practical framework for e-commerce companies to use big data for long-term success is laid out in the results. In order to stay ahead of the competition in the fiercely competitive digital industry, e-commerce platforms are employing new analytical approaches to improve customer service and achieve operational excellence.

Kadya, Vikranth & Karani, Krishna Prasad (2020) The most recent development in international trade is e-commerce. Businesses may now conduct their operations online because to the proliferation of innovative technologies such as the internet, networks, and satellites. Modern e-commerce has an endless cultural impact, altering people's daily routines all across the globe. Everyone from producers to retailers to wholesalers and consumers will feel the effects of this. Plenty of organizations have stepped up and started e-commerce ventures in the previous 60 years, with 80% of those enterprises going on to achieve tremendous market success. Now more than

ever, data analytics are a must for companies looking to stay afloat in the competitive e-commerce industry. When conducting business online, a great deal of data is created in many different areas, including advertisements, information interchange, order and payment processing, delivery, customer service, and reviews. Finding ways to use the data to make the product even better is the biggest challenge for the organization. These businesses are now establishing research departments to analyze data using various technologies; this department helps the firm make informed decisions and contributes to its bottom line. Walmart has extended its market in twenty-eight nations worldwide and is the leading seller in the US. Now it was fighting an uphill battle to maintain its position as market leader in the face of intense competition. Consequently, it was deliberate to employ specialized research teams to sift through massive volumes of data from the current dataset spanning a number of years. This paper covered a lot of ground: what is the e-commerce industry, what data can be generated by it, why it's important to analyze this data, what technologies are needed to do this analysis, how companies use datasets to stay competitive, and how Walmart uses data analytics to understand its business scenario.

Akter, Shahriar & Fosso Wamba, Samuel. (2016) Over the past few years, big data analytics (BDA) has become more important in the e-commerce business. Nevertheless, the lack of thorough investigation of the notion hinders its advancement in theory and practice. By means of a comprehensive literature analysis, this position paper delves into BDA as it pertains to online commerce. Examining the definition, kinds, special qualities, commercial value, and problems of BDA in the e-commerce ecosystem, this article proposes an interpretative framework. More general conversations on theoretical and practical research opportunities and threats in the future are also sparked by the study. In sum, the study's results shed light on the many cross-cutting analytics applications in e-commerce by integrating several BDA principles (such as the definition, types, nature, commercial value, and applicable theories of big data).

III. RESEARCH METHODOLOGY

Research Design

Using a quantitative research approach, this study looks at how e-commerce companies may improve their inventory management and dynamic pricing systems by utilizing Big Data Analytics (BDA).

Sources of Data

Primary Data: Structured questionnaires and surveys will be used to gather primary data from e-commerce companies' managers and decision-makers who have used Big Data Analytics technologies. The purpose of this survey is to gather information on how people have used BDA for making pricing decisions, optimizing inventory, and improving operational efficiency.

Secondary Data: Organizational records and published sources will be used to gather secondary data. This data will come from e-commerce companies' financial statements, sales reports, inventory records, and internal performance dashboards. We will compare the results from Pre and Post BDA installation using this data.

Sampling Design

The study employs a purposive sampling technique.

Sample Size

This study's sample size includes 30 e-commerce businesses and managers that have used Big Data Analytics (BDA) for pricing and inventory management.

Statistical Tools and Techniques

Mean and standard deviation are examples of descriptive statistics used to summarize data for analysis. To determine if there are statistically significant changes in critical performance indicators between the pre- and post-BDA periods, we use a paired sample t-test.

IV. DATA ANALYSIS AND INTERPRETATION

Table 1: Descriptive Statistics of E-Commerce Performance Pre and Post BDA Implementation

Variable	Pre BDA Implementation (Mean)	Post BDA Implementation (Mean)	Improvement (%)

Pricing Accuracy (%)	72.00	88.00	22.22
Inventory Turnover (Units)	210	295	40.48
Sales Volume (Units Sold)	9,500	14,200	49.47
Stockouts (%)	16.00	6.00	-62.50
Excess Inventory (%)	13.00	5.00	-61.54

Key e-commerce performance metrics' descriptive statistics both Pre and Post Big Data Analytics (BDA) deployment are shown in Table 1. The data show that Post using BDA, operational and sales performance significantly improved. The mean value of pricing accuracy improved by 22.22 percentage points during the pre- and post-BDA periods, going from 72.00 percent to 88.00 percent. This indicates that the accuracy of price decisions was much improved by dynamic pricing models that were allowed by BDA.

Additionally, inventory turnover increased significantly, going from 210 units Pre BDA adoption to 295 units Post, a 40.48 percent improvement. The use of data-driven demand forecasting and replenishment tactics has led to more effective inventory management and speedier products movement. Similarly, sales volume increased dramatically, going from 9,500 units to 14,200 units, a 49.47% boost; this demonstrates the beneficial effect of BDA on sales performance and the fulfillment of client demand.

However, with the implementation of BDA, important inefficiency metrics like stockouts and excess inventory shown a significant decrease. The percentage of stockouts decreased from 16% in the time Pre BDA to 6% in the period Post BDA, representing a decrease of 62.50%. Similarly, there was a 61.54% drop in surplus inventories, which went from 13% to 5%. These savings show

that better inventory planning and managing stock levels optimally contributed to the reductions.

Table 2: Paired Sample t-Test Results for E-Commerce Performance Pre and Post BDA Implementation

Variable	Mean (Pre BDA)	Mean (Post BDA)	Mean Difference	t-value	Sig. (2-tailed)
Pricing Accuracy (%)	72.00	88.00	16.00	8.45	0.000
Inventory Turnover (Units)	210.00	295.00	85.00	6.98	0.000
Sales Volume (Units Sold)	9,500.00	14,200.00	4,700.00	7.84	0.000
Stockouts (%)	16.00	6.00	-10.00	-5.92	0.000
Excess Inventory (%)	13.00	5.00	-8.00	-6.41	0.000

The findings of the paired sample t-test that was used to compare e-commerce performance indicators before and after Big Data Analytics (BDA) adoption are shown in Table 2. With significance levels ($p = 0.000$) that are significantly lower than the 0.05 threshold, the study shows that all chosen variables change in a statistically significant way between the pre- and post-BDA periods.

Mean pricing accuracy increased from 72.00 in the pre-BDA era to 88.00 in the post-BDA period, indicating a significant improvement. Adopting BDA has significantly improved pricing precision through data-driven decision-making, as shown by the high t-value of 8.45 and positive mean difference of 16.00. Likewise, after implementing BDA, inventory turnover increased significantly from 210.00 units to 295.00 units, with a mean difference of 85.00 units and a t-value of 6.98. This

indicates quicker stock movement and higher efficiency in inventory usage.

From 9,500 to 14,200 units sold, there is a huge and statistically significant increase in sales volume. With a t-value of 7.84 and a huge mean difference of 4,700 units, BDA clearly boosts sales performance through enhanced pricing strategies and better demand forecasts. On the other hand, operational inefficiencies like surplus and stockouts are far less common after BDA. Improving inventory management and reducing wastage are indicated by a 10.00 percentage point drop in stockouts and an 8.00 percentage point drop in excess inventory, both supported by a negative t-value of -5.92 and -6.41 , respectively.

V. CONCLUSION

Big Data Analytics (BDA) adoption significantly improves e-commerce firms' operational and sales performance, according to the research. Findings demonstrate the revolutionary impact of data-driven decision-making on dynamic pricing and inventory management systems through a systematic comparison of key performance metrics before and after BDA deployment. The results show that after implementing BDA, there was a significant uptick in price accuracy, inventory turnover, and sales volume, suggesting a better ability to respond to consumer demand and market trends. Improvements in demand forecasting, inventory planning, and stock level management have led to a marked decrease in both surplus and shortage of inventory. These upgrades boost operational efficiency, customer happiness, and cost reduction all at once. The findings are further supported by the results of the paired sample t-test, which demonstrate that the observed improvements are statistically significant. This is solid proof that e-commerce companies may use Big Data Analytics to improve the alignment of supply and demand, automate inventory operations, and make more accurate price decisions.

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