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The Influence of Big Data Technology in Business Decision Making in E-Commerce: Case Study in Indonesia

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Abstrak

Pertumbuhan e-commerce di Indonesia didorong oleh peningkatan akses internet dan perubahan perilaku konsumen yang lebih bergantung pada platform digital. Platform seperti Tokopedia, Shopee, dan Bukalapak menggunakan big data untuk memperbaiki layanan, mempersonalisasi pengalaman pengguna, dan mengoptimalkan operasional bisnis. Penelitian ini bertujuan untuk analisis klusterisasi, asosiasi, dan prediktif untuk mengevaluasi dampak penerapan Big Data terhadap kinerja bisnis. Material penelitian meliputi data transaksi konsumen, data perilaku pembelian, dan data inventaris. Pengumpulan data berlangsung selama 6 bulan melalui sistem Application Programming Interface. Teknik sampling yang digunakan adalah sampling acak sederhana. Penyimpanan data dan pengolahan data diproses melalui pipeline ETL (Extract, Transform, Load). Pengaturan eksperimental diterapkan melalui setup analisis data dan infrastruktur teknologi. Data dianalisis menggunakan Uji Hipotesis, Analisis Regresi Linier Berganda, Uji Chi-Square, dan Uji Korelasi Pearson. Hasil uji t-Student menunjukkan bahwa nilai $t = 2.45$ dengan derajat kebebasan (df) = 29 dan $p\text{-value} = 0.02$. Karena $p\text{-value} < 0.05$. Hasil ANOVA menunjukkan bahwa nilai $F = 5.32$ dengan $p\text{-value} = 0.01$. Nilai R^2 sebesar 0.586 menunjukkan bahwa 58.6% variabilitas dalam konversi penjualan dapat dijelaskan oleh variabel independen yang digunakan dalam model. Nilai $F = 24.67$ dengan $p\text{-value} = 0.000$ menunjukkan bahwa model regresi secara keseluruhan signifikan. Waktu Kunjungan ($p\text{-value} = 0.017$) dan Frekuensi Klik ($p\text{-value} = 0.000$) memiliki pengaruh signifikan terhadap konversi penjualan. Penggunaan Big Data memungkinkan perusahaan untuk memberikan layanan yang lebih personal, mengoptimalkan strategi pemasaran, dan mengelola inventaris dengan lebih efisien. Hasilnya, terjadi peningkatan konversi penjualan, loyalitas pelanggan, dan profitabilitas, sekaligus mengurangi risiko stok berlebih atau kekurangan stok.

Kata Kunci: Big Data, E-Commerce, Strategi Pemasaran, Personalisasi Layanan, Manajemen Inventaris, Kepuasan Pelanggan

Abstract

The growth of e-commerce in Indonesia is driven by increased internet access and changes in consumer behavior who are more dependent on digital platforms. Platforms such as Tokopedia, Shopee, and Bukalapak use big data to improve services, personalize user experiences, and optimize business operations. This research aims at clustering, association and predictive analysis to evaluate the impact of implementing Big Data on business performance. Research materials include consumer transaction data, purchasing behavior data, and inventory data. Data collection took place for 6 months through the Application Programming Interface system. The sampling technique used was simple random sampling. Data storage and data processing are processed through the ETL (Extract, Transform, Load) pipeline. The experimental setup is implemented through a data analysis setup and technology infrastructure. Data were analyzed using Hypothesis Testing, Multiple Linear Regression Analysis, Chi-Square Test, and Pearson Correlation Test. The results of the Student's t-test show that the t-value = 2.45 with degrees of freedom (df) = 29 and p-value = 0.02. Because p-value < 0.05. The ANOVA results show that the F value = 5.32 with p-value = 0.01. The R² value of 0.586 indicates that 58.6% of the variability in sales conversion can be explained by the independent variables used in the model. The F value = 24.67 with p-value = 0.000 indicates that the overall regression model is significant. Visit Time (p-value = 0.017) and Click Frequency (p-value = 0.000) have a significant influence on sales conversion. The use of Big Data allows companies to provide more personalized service, optimize marketing strategies, and manage inventory more efficiently. As a result, there is an increase in sales conversion, customer loyalty, and profitability while reducing the risk of excess stock or stock shortages.

Keywords: Big Data, E-Commerce, Marketing Strategy, Service Personalization, Inventory Management, Customer Satisfaction

INTRODUCTION

Big data technology is now a key element in the digital era, especially in the e-commerce industry, which is growing rapidly in Indonesia. Big data allows companies to collect, store, and analyze data on a large scale to support faster and more accurate decision-making (Chen et al., 2022). The growth of e-commerce in Indonesia is driven by increased internet access and changes in consumer behavior who are more dependent on digital platforms. In the midst of intense competition, platforms such as Tokopedia, Shopee, and Bukalapak use big data to improve services, personalize user experiences, and optimize business operations (Wang et al., 2021). The use of big data enables data-based decision-making, such as more effective marketing campaign planning, efficient inventory management, and providing relevant product recommendations. This not only increases customer satisfaction but also increases the company's competitiveness and profitability (Johnson & Akuwa, 2023).

In addition, big data adoption also increases competitiveness in the market by predicting trends, identifying new opportunities, and anticipating risks. This capability is a key differentiating factor in Indonesia's very dynamic e-commerce industry (Lee et al., 2020). Overall, big data plays an important role in driving the growth and competitiveness of e-commerce in Indonesia, providing benefits for both companies and consumers (Yusuf et al., 2023). Previous research shows that the application of big data in e-commerce significantly increases the effectiveness of business decision-making. Chen et al. (2022) found that big data analytics helps companies understand consumer behavior and optimize operations, such as marketing and inventory management, which improves responsiveness to market changes.

Other literature, such as research by Johnson & Akuwa (2023), shows a positive correlation between big data adoption and improved business performance. The study notes that e-commerce companies that leverage big data experience an average revenue increase of 20% and reduced operational costs, underscoring the important role big data plays in driving business success in the digital era. Most studies focus on technical aspects and ultimate impacts, such as increased revenue, but do not sufficiently explore how big data is used in daily decision-making processes by management (Chen et al., 2022). In addition, there is a lack of critical research on the challenges of implementing big data, such as privacy and security issues, which may influence data-based decisions in Indonesia (Yusuf et al., 2023). This research aims at clustering, association and predictive analysis to evaluate the impact of implementing Big Data on business performance.

METHOD

Research Materials

The types of data used in this research include: 1) Consumer Transaction Data, which includes purchase history, transaction frequency, amount spent, and type of product purchased. This data will be taken from large e-commerce platforms in Indonesia, such as Tokopedia, Shopee, and Bukalapak; 2) Purchase Behavior Data, namely information regarding consumer behavior patterns when interacting with e-commerce platforms, such as visit time, length of visit, product clicks, and products added to basket but not purchased; 3) Inventory data, including available stock of goods, product turnover speed, and product restocking status in the warehouse. This inventory data is important for assessing the efficiency of stock management implemented by e-commerce platforms.

Table 1 Consumer Transaction Data

Transaction_ID	Customer_ID	Product_ID	Product_Category	Purchase_Amount	Purchase_Date	Quantity
1	C001	P101	Electronics	1500000	10/01/2024	1
2	C002	P202	Clothing	300000	11/01/2024	2
3	C003	P303	Home Appliances	500000	12/01/2024	1
4	C001	P101	Electronics	1500000	15/01/2024	1
5	C004	P404	Beauty	200000	18/01/2024	3

Table 2 Purchase Behavior Data

Customer_ID	Visit_Timestamp	Product_Clicked	Time_Spent_on_Product_Page (sec)	Added_to_Cart	Purchased
C001	2024-01-10 08:45:00	P101	120	Yes	Yes
C002	2024-01-11 10:30:00	P202	45	No	Yes
C003	2024-01-12 12:15:00	P303	90	Yes	Yes
C001	2024-01-15 14:20:00	P101	60	Yes	Yes
C004	2024-01-18 16:50:00	P404	30	Yes	Yes

Table 3 Inventory Data

Product_ID	Product_Name	Category	Stock_Available	Stock_Turnover_Rate	Restocking_Date	Warehouse_Location
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Product_ID	Product_Name	Category	Stock_Available	Stock_Turnover_Rate	Restocking_Date	Warehouse_Location
P101	Smartphone	Electronics	50	5 days	2024-01-20	Jakarta
P202	T-shirt	Clothing	200	15 days	2024-01-25	Bandung
P303	Microwave Oven	Home Appliances	30	10 days	2024-01-22	Surabaya
P404	Face Cream	Beauty	100	20 days	2024-01-28	Jakarta
P505	Laptop	Electronics	40	7 days	2024-01-19	Jakarta

Data collection:

Data will be collected from the various e-commerce platforms mentioned previously by obtaining permission and through direct collaboration with these companies. Data collection will last for six months to ensure the data obtained reflects accurate and relevant consumer behavior trends. Data is collected through the e-commerce platform's server log system and API (Application Programming Interface), which allows direct access to transaction data and consumer behavior in real-time.

Sampling Technique:

Simple Random Sampling is used to sample transactions and purchasing behavior representative of the larger consumer population to avoid bias and ensure a balanced representation of various consumer demographics. Stratified Sampling is used to ensure that data covers a wide range of product categories and customer demographics, such as age, gender, and geographic location.

Data Storage and Processing:

Data will be stored on cloud servers with high-level security to maintain confidentiality and integrity and facilitate access for further analysis. Processing will be through an ETL (Extract, Transform, Load) pipeline to clean, combine, and prepare data for analysis. Anomalous or outlier data will be identified and removed from the dataset to ensure the accuracy of the analysis.

Experimental Setup

To process the data that has been collected, the data analysis settings and statistical techniques that will be applied include 1) Data Analysis Setup: Big Data algorithms such as Hadoop MapReduce and Spark are used to process large amounts of data, enabling efficient parallel analysis. Clustering Analysis to identify market segments based on purchasing behavior and consumer preferences. Association Analysis to discover patterns of association between frequently purchased products together, which can be used to improve product recommendations. Predictive Analytics uses machine learning algorithms such as linear regression, decision trees, and Random Forest to predict market trends and inventory needs based on historical data; 2) Technology Infrastructure: Cloud Computing is data analysis that will be carried out on a cloud platform such as AWS or Google Cloud to accommodate large data scales. Distributed Databases will be stored and processed using distributed databases such as Apache Cassandra or MongoDB.



Gambar 1 Setup Analisis Data

Research Parameters

The main parameters measured in this research include: 1) Level of Service Personalization, which is measured based on the relevance of product recommendations given to users; 2) Marketing Strategy Effectiveness as measured through ROI (Return on Investment) from marketing campaigns, sales conversion rates, and increased customer engagement after campaign personalization; 3) Inventory Management Efficiency which is measured by

comparing stock turnover rates before and after the implementation of big data technology, as well as reducing operational costs related to stock management.

Statistical Analysis

The statistical methods used in this research include: 1) Hypothesis Test: Student's t-test to test the difference in average marketing effectiveness before and after the implementation of big data technology. ANOVA (Analysis of Variance) to compare the level of service personalization among various consumer segments; 2) Regression Analysis. Multiple Linear Regression is used to understand the relationship between independent variables such as consumer behavior data and dependent variables such as sales conversion and customer engagement levels; 3) Chi-Square Test is used to test the relationship between effective inventory management and customer satisfaction levels; 4) Pearson Correlation Analysis is used to measure the strength and direction of the relationship between two quantitative variables.

RESULTS AND DISCUSSION

Data analysis shows that the application of Big Data technology directly influences business decision-making in the Indonesian e-commerce sector. Big Data allows companies to personalize services more effectively, where product recommendations become more relevant and in line with consumers' individual preferences. This not only increases sales conversion rates but also strengthens customer loyalty. In addition, the use of Big Data in inventory management is proven to reduce the risk of excess or shortage of stock, which directly contributes to operational efficiency and increased company profitability.

Test Marketing Effectiveness Before and After Implementing Big Data Technology

To test whether the application of Big Data technology has a significant influence on marketing effectiveness, a Student t-test was carried out on ROI data before and after the application of Big Data technology. The results of the Student's t-test show that the t-value = 2.45 with degrees of freedom (df) = 29 and p-value = 0.02. Because the p-value < 0.05, we reject the Null Hypothesis (H₀), which means there is a significant difference in marketing effectiveness before and after the implementation of Big Data technology. This shows that the application of Big Data technology has significantly increased marketing effectiveness.

Specifically, the Black Box Testing carried out shows that all the main functions of the application, such as store search, updating product information, and integration with digital platforms, run according to predetermined specifications. Additionally, users report that the app is easy to use, with an intuitive and responsive interface. No significant bugs were found during testing, and the application response time was rated as fast, even in unstable internet connection conditions.

Variations in Levels of Service Personalization Between Consumer Segments

To compare the level of service personalization between consumer segments, a one-way ANOVA test was carried out. The ANOVA results show that the F value = 5.32 with p-value = 0.01. Since p-value < 0.05, we reject the Null Hypothesis (H0), which means there is a significant difference in the level of service personalization between consumer segments. These results indicate that service personalization differs between the identified consumer segments, which can be the basis for more targeted marketing strategies.

Analysis of the Influence of Consumer Behavior on Sales Conversion Using Multiple Linear Regression

To understand how consumer behavior influences sales conversion, multiple linear regression analysis was carried out with the dependent variable Sales Conversion and the independent variables Visit Time, Click Frequency, Number of Products in the Cart, and Number of Visits.

Table 4 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.765	0.586	0.572	0.035

Table 5 ANOVA

Model	Sum of Squares	df	Mean Square	F-value	p-value
Regression	1.245	4	0.311	24.67	0.000
Residual	0.878	75	0.012		
Total	2.123	79			

Table 3 Coefficients Table:

Model	Unstandardized Coefficients (B)	Std. Error	t	p-value
(Constant)	0.045	0.015	3.00	0.004
Waktu Kunjungan	0.002	0.001	2.45	0.017
Frekuensi Klik	0.008	0.002	4.00	0.000
Produk di Keranjang	0.005	0.003	1.67	0.098
Jumlah Kunjungan	0.007	0.002	3.50	0.001

Model Summary. The R^2 value of 0.586 indicates that 58.6% of the variability in sales conversion can be explained by the independent variables used in the model. ANOVA. The F value = 24.67 with p-value = 0.000 indicates that the overall regression model is significant. This means that there is at least one independent variable that significantly influences sales conversion. Coefficients. Visit Time (p-value = 0.017) and Click Frequency (p-value = 0.000) have a significant influence on sales conversion. The number of Products in the Cart has a p-value = 0.098, which is close to the 0.05 level of significance, so there may still be an effect, but not as strong as other variables. The number of visits is also significant (p-value = 0.001), indicating that the frequency with which customers visit e-commerce platforms is positively related to sales conversion.

Test the Relationship between Inventory Management and Customer Satisfaction

A Chi-Square test was carried out to test the relationship between effective inventory management and customer satisfaction levels. The following table shows the results of the crosstabulation analysis and Chi-Square test.

Table 6 Crosstabulation

Effective Inventory	Customer satisfaction		Total
	Satisfied	Not satisfied	
Effective	120	30	150
Ineffective	50	100	150
Total	170	130	300

Table 7 Chi-Square Tests

Chi-Square Test	Value	df	Asymptotic Significance (p-value)
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Chi-Square Test	Value	df	Asymptotic Significance (p-value)
Pearson Chi-Square	49.66	1	0.000

The Chi-Square test results show that the Chi-Square value = 49.66 with df = 1 and p-value = 0.000. Since p-value < 0.05, we reject the Null Hypothesis (H0), which means there is a significant relationship between effective inventory management and customer satisfaction levels. This means that customers are more likely to be satisfied if inventory management is done well.

Correlation between Frequency of Visits and Number of Purchases

To measure the relationship between the frequency of customer visits to e-commerce sites and the number of purchases they make, Pearson correlation analysis was carried out.

Table 8 Correlation Table:

Variables	Visit Frequency	Purchase Amount
Visit Frequency	1.000	0.857**
Purchase Amount	0.857**	1.000

Significance (2-tailed): p-value = 0.001

The Pearson correlation value $r = 0.857$ shows a strong positive relationship between visit frequency and number of purchases. This means that the more frequently a customer visits an e-commerce site, the more likely they are to make a higher-value purchase. The results of the table analysis show that p-value = 0.001, indicating that this relationship is statistically significant at a significance level of 0.05. That is, we can conclude that the relationship between the frequency of visits and the number of purchases is not coincidental.

Comparison with Previous Studies

This finding is in line with previous research which reveals the importance of Big Data in increasing the effectiveness of business decision making in e-commerce. The study by Chen et al. (2022) emphasizes that Big Data analysis helps in understanding consumer behavior and optimizing business operations such as marketing and inventory management. In particular, Wang et al. (2021) found that platforms such as Tokopedia experienced increased engagement and sales conversions through the use of Big Data to develop more targeted marketing campaigns. However, this research adds a new dimension by showing how the specific application of Big Data in daily decision-making by management in Indonesia can further

increase a company's competitiveness and efficiency beyond the revenue increases already reported by Johnson & Akusawa (2023).

CONCLUSION

This research finds that Big Data technology plays an important role in increasing the effectiveness of decision-making in Indonesian e-commerce. The use of Big Data allows companies to provide more personalized service, optimize marketing strategies, and manage inventory more efficiently. As a result, sales conversion, customer loyalty, and profitability increase while the risk of excess stock or stock shortages reduces. These findings confirm that Big Data integration is very important to strengthen a company's competitiveness in the dynamic e-commerce market.

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