

Analysis Performance of Digital Payment System in the *E-Commerce* Ecosystem

Mohammad Harits Akbar^{1,a)}, Muhammad Henriansyah^{2,b)}, Mercurius Broto
Legowo^{3,c)}

^{1,2}Data Science Study Program, Faculty of Information Technology, Perbanas Institute Jakarta,

³Information System Study Program, Faculty of Information Technology, Perbanas Institute
Jakarta

^{a)}Corresponding Author: mohammad.harits01@perbanas.id,

^{b)}muhammad.henriansyah02@perbanas.id

^{c)}mercurius@perbanas.id

Abstract. *The development of digital payment systems has changed transaction patterns within the modern e-commerce ecosystem. This study aims to analyze and compare the performance of various digital payment methods on e-commerce platforms based on transaction characteristics and consumer behavior. The study uses a quantitative approach with a comparative analysis method on e-commerce transaction datasets through stages of data preprocessing, exploratory data analysis (EDA), correlation analysis, and One-Way ANOVA statistical testing. The analysis focuses on payment methods such as Credit Card, Debit Card, COD, UPI, PayPal, and E-Wallet to identify usage patterns and differences in transaction performance among payment methods. The results of the study show that digital payment methods have relatively similar transaction patterns in relation to consumer transaction values. The ANOVA test results indicate that there are no significant differences in average transactions among the payment methods. In addition, Credit Cards have become the most dominant payment method because they have advantages in payment flexibility, transaction security, as well as various promotional and reward programs. Research findings show that consumers tend to choose payment methods based on convenience and accessibility rather than the purchase amount. This study contributes to understanding the role of digital payment systems in supporting the efficiency and stability of the e-commerce ecosystem.*

Key Words: ANOVA, Comparative Analysis ,Digital Payment System, E-Commerce

I. INTRODUCTION

The development of digital payment systems in Indonesia has experienced very rapid growth in recent years, along with the increasing transaction activities in the e-commerce ecosystem. Bank Indonesia reported that the volume of digital payment transactions in 2025 continued to show significant increases. In January 2025, digital payment transactions through QRIS grew by 175.2% year on year, supported by the increase in the number of users and digital merchants. In addition, Bank Indonesia also reported that the volume of digital payment transactions at the beginning of 2026 grew by nearly 40% year on year (Bank Indonesia, 2025). This increase indicates that digital payment systems have become an important part of modern society's economic and electronic commerce activities.

The development of e-commerce platforms has also changed purchasing behavior and consumer transaction patterns, who increasingly rely on various digital payment methods such as credit cards, debit cards, e-wallets, bank transfers, and cash on delivery (COD) to conduct online transactions. Each payment method has different characteristics in terms of ease of use, transaction security, payment speed, transaction

promotions, and operational efficiency. Digital payment systems have become one of the main factors affecting consumer experience in modern electronic commerce activities (Chaffey, 2023).

Several previous studies have focused more on the adoption of digital payments, user acceptance, and technological readiness in financial technology systems. Trust and ease of use factors have a significant influence on digital payment adoption among e-wallet users in Indonesia (Rizkiyah et al., 2024). In addition, the use of digital payment systems such as paylater also affects the impulse buying behavior of e-commerce users in Indonesia (Bachtiar, 2024). Other studies also show that security, the completeness of payment methods, and transaction speed are important factors influencing consumer purchasing behavior on digital e-commerce platforms in Indonesia (Rahma, 2025). Nevertheless, research that specifically discusses comparative performance between payment methods within the e-commerce ecosystem using transaction analysis approaches is still relatively limited.

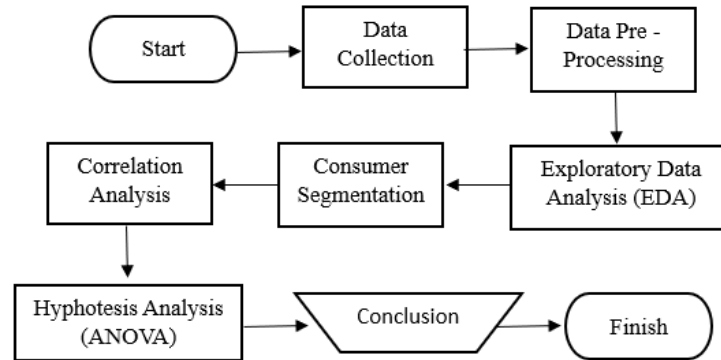


FIGURE 1. Research Framework

This research not only focuses on the level of adoption or acceptance of digital payment technology, but places greater emphasis on analyzing the performance of payment methods within the e-commerce ecosystem based on actual transaction data. This study uses a comparative analysis approach to compare various payment methods based on transaction value, profit margin, shipping costs, return rates, discount intensity, and consumer behavior. In addition, this research also integrates exploratory data analysis, correlation analysis, and ANOVA statistical tests to identify differences in performance between payment methods more comprehensively. With this approach, the study is expected to provide deeper insights into the effectiveness of digital payment systems in supporting transaction stability and operational efficiency on e-commerce platforms.

II. LITERATURE REVIEW

Digital Payment System

The payment system becomes a main component because it functions as a link between consumers and e-commerce platforms (Martadinata and Zaliman, 2021). Bank Indonesia states that the digital payment system plays an important role in increasing the efficiency of economic transactions, accelerating the circulation of digital money, and supporting the development of technology-based economy (Bank Indonesia, 2025). Ease of use and level of trust are the main factors influencing the use of digital payments among Indonesian people (Rizkiyah et al., 2024).

E-Commerce Ecosystem

In practice, the success of the e-commerce ecosystem is greatly influenced by the effectiveness of digital payment systems, the quality of logistics services, and the user experience in conducting online transactions

(Wibowo et al, 2024). Certain payment methods also have a relationship with transaction intensity, customer loyalty, and the rate of product returns on e-commerce platforms (Nugroho, 2023).

Consumer Behavior toward Digital Payments

Research by Rizkiyah et al. (2024) shows that ease of use and security perception factors have a significant influence on the use of digital payments among the Indonesian community. In addition, the development of digital payment services such as paylater and e-wallets also affects consumer purchasing behavior on e-commerce platforms. Research by Umam and Bachtiar (2024) shows that the use of digital payment systems influences the impulse buying behavior of e-commerce users in Indonesia.

Comparative Analysis on Digital Payment Systems

Comparative analysis is an analytical method used to compare performance between groups based on certain indicators. In this research, comparative analysis is used to compare the performance of payment methods based on transaction value, profit margin, shipping costs, product return rates, and consumer behavior.

The quality of digital payment systems on e-commerce platforms can affect user convenience, transaction effectiveness, and customer loyalty (Rahma, 2025). Digital payment methods that have faster and more stable transaction processes tend to provide a higher level of customer satisfaction compared to conventional payment methods (Hidayati & Permana, 2024). Analyzing the performance of payment methods becomes important to understand the effectiveness of each payment system in supporting digital commerce activities. A comparative analysis approach also allows researchers to identify the most efficient payment methods in supporting transactions on e-commerce platforms.

III. METHODS

This research applies a quantitative approach using a comparative analysis method. This approach was chosen to evaluate, test, and compare the operational performance and transaction characteristics of various digital payment methods available within the e-commerce ecosystem, which are grouped into six main categories of payment methods, including Credit Card, Debit Card, Cash on Delivery (COD), UPI, PayPal, and E-Wallet.

To produce a comprehensive analysis, all stages of data comparison were implemented using Python-based data analytics techniques with Anaconda Navigator and Jupyter Notebook as the data analysis development environment. This methodology consists of five main stages: (1) data collection, (2) data cleaning (data preprocessing), (3) descriptive analysis (exploratory data analysis), (4) correlation analysis, (5) comparative hypothesis testing using one-way ANOVA (One-Way Analysis of Variance) inferential statistical tests.

To measure and compare the performance of each of these payment methods, this study extracts and analyzes several research variables grouped into three main indicators:

- **Characteristics of Transactions and Profitability:** Measured through the variables of nominal purchase value (Total Purchase Amount) and profit margin (Profit Margin).
- **Logistics Operational Efficiency:** Measured through the variables of shipping cost and delivery time duration.
- **Consumer Transaction Behavior:** Measured through the variable product return rate, the intensity or frequency of discount usage, as well as customer segmentation patterns.

Data Preprocessing

Before further analysis is conducted, the raw data first goes through initial processing stages (data preprocessing) to ensure the quality and integrity of the data (data integrity). This process of manipulating and cleaning the data is executed using the Pandas library in Python.

Perbanas International Conference on Economics, Business, Management, Accounting and IT
(PROFICIENT) 2026

“Integrity-Driven Innovation: Reimagining Business, Finance, and Digital Transformation for Sustainable Impact”

Proceedings of the Perbanas International Seminar on Economics, Business, Management, Accounting and IT
[June 2026] [ISSN 3047-0951]

The preprocessing stages include the identification and handling of missing values through deletion methods (dropna) or filling values (fillna) in incomplete rows of data. Next, data type alignment is carried out, especially for categorical variables and date formats, so that they can be read consistently by the system.

Data Analysis Techniques

The data analysis techniques in this study were divided into three main, interconnected stages. The first stage was Exploratory Data Analysis (EDA), which focused on descriptive analysis to identify the basic characteristics, distribution, and patterns of transaction data. Data visualization was created using the Matplotlib and Seaborn libraries to display bar charts to demonstrate the frequency of payment method use, and boxplots to examine the contours of the distribution of transaction amounts for each payment instrument.

The second stage was Correlation Analysis, where Pearson correlation analysis was applied to identify the direction and strength of linear relationships between numerical variables in the dataset, such as transaction value, profit margin, discount amount, and return rate. The results of this correlation were then visually mapped using a correlation heatmap to more easily identify patterns of relationships between variables.

The third stage was Analysis of Variance (ANOVA). One-Way ANOVA was used to test whether there was a significant difference in average transaction value between payment methods, with a significance level of 5% ($\alpha = 0.05$). The results of this test also serve as statistical validation of the findings obtained in the previous EDA stage.

IV. RESULTS AND DISCUSSION

The e-commerce transaction dataset was successfully fully loaded into the system, where the first five rows of data were used to conduct an initial inspection of the available attribute structure. The data preprocessing process began by aligning the column names from English to Indonesian to facilitate visualization and interpretation of the data in the subsequent stage.

TABLE 1. Payment System Tracking Dataset

	order_id	customer_id	product_id	category	price	discount	quantity	payment_method	order_date	delivery_time_days	region	returned	total_amount
0	O100000	C17270	P234890	Home	164.08	0.15	1	Credit Card	23/12/2023	4	West	No	139.47
1	O100001	C17603	P228204	Grocery	24.73	0.00	1	Credit Card	03/04/2025	6	South	No	24.73
2	O100002	C10860	P213892	Electronics	175.58	0.05	1	Credit Card	08/10/2024	4	North	No	166.80
3	O100003	C15390	P208689	Electronics	63.67	0.00	1	UPI	14/09/2024	6	South	No	63.67
4	O100004	C15226	P228063	Home	16.33	0.15	1	COD	21/12/2024	6	East	No	13.88

Perbanas International Conference on Economics, Business, Management, Accounting and IT
(PROFICIENT) 2026
“Integrity-Driven Innovation: Reimagining Business, Finance, and Digital Transformation for Sustainable Impact”

Proceedings of the Perbanas International Seminar on Economics, Business, Management, Accounting and IT
[June 2026] [ISSN 3047-0951]

discount	quantity	payment_method	order_date	delivery_time_days	region	returned	total_amount	shipping_cost	profit_margin	customer_age	customer_gender
0.15	1	Credit Card	23/12/2023	4	West	No	139.47	7.88	31.17	60	Female
0.00	1	Credit Card	03/04/2025	6	South	No	24.73	4.60	-2.62	37	Male
0.05	1	Credit Card	08/10/2024	4	North	No	166.80	6.58	13.44	34	Male
0.00	1	UPI	14/09/2024	6	South	No	63.67	5.50	2.14	21	Female
0.15	1	COD	21/12/2024	6	East	No	13.88	2.74	1.15	39	Male

After the Preprocessing stage was carried out, as a result, the dataset has been cleaned and is considered ready for further analysis and has no missing values in any of its columns. As a final step to maintain data integrity, the transaction timestamp column was explicitly transformed into datetime format to be ready for time series-based analysis. Based on these series of stages, the dataset is declared clean, consistent, and ready to be analyzed in the Exploratory Data Analysis (EDA) stage.

After the basic characteristics of the dataset attributes were successfully identified, the analysis stage continued by conducting Exploratory Data Analysis (EDA).

```

: # Exploratory Data Analysis (EDA)
#Distribusi Metode Pembayaran

#Tujuan: Melihat metode pembayaran paling dominan

import matplotlib.pyplot as plt
import seaborn as sns

# Hitung jumlah transaksi berdasarkan payment method
payment_counts = (
    sales['Metode_Pembayaran']
    .value_counts()
    .reset_index()
)

payment_counts.columns = ['Metode_Pembayaran', 'count']

# Cek tabel hasilnya dulu
payment_counts

```

FIGURE 2. Exploratory Data Analysis (EDA) Process

In this study, the application of Exploratory Data Analysis (EDA) has several crucial objectives, including:

- Mapping consumer preferences and behavior patterns in choosing digital payment instruments within the e-commerce ecosystem.
- Detecting the forms of nominal transaction value distribution (Total Purchase Amount) for each payment method visually before being verified through inferential statistical tests.
- Identifying the existence of special tendencies or anomalies in data distribution that may influence operational decision-making.

As a manifestation of this exploration stage, the following presents a visualization of the frequency distribution of usage for each payment method actively used by consumers.

Perbanas International Conference on Economics, Business, Management, Accounting and IT
(PROFICIENT) 2026

“Integrity-Driven Innovation: Reimagining Business, Finance, and Digital Transformation for Sustainable Impact”

Proceedings of the Perbanas International Seminar on Economics, Business, Management, Accounting and IT
[June 2026] [ISSN 3047-0951]

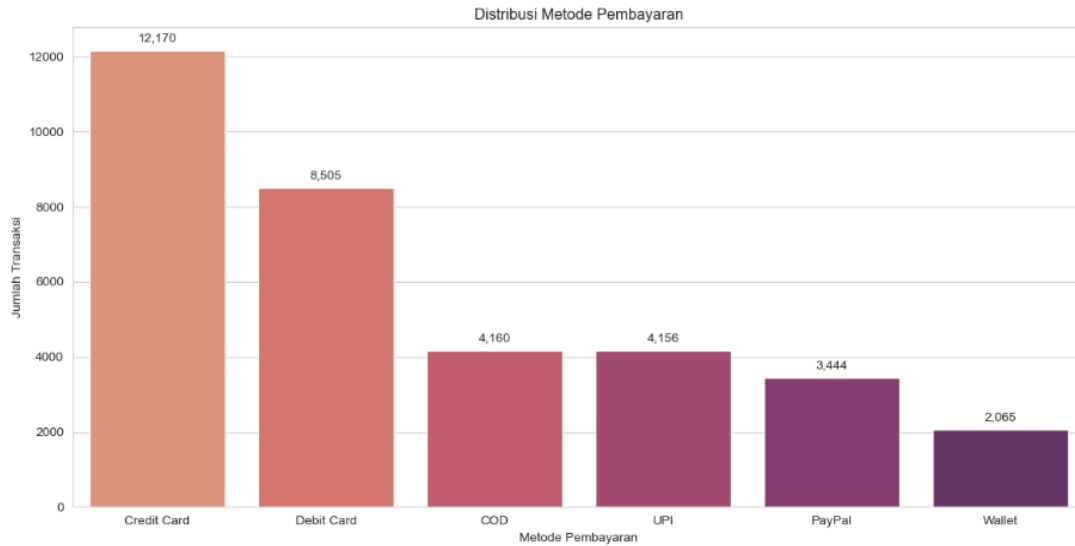


FIGURE 2. Visualisasi Distribusi Metode Pembayaran

Based on the frequency distribution graph in Figure 2, it can be clearly observed that Credit Card occupies the highest position and dominates as the most widely used instrument by consumers in this e-commerce ecosystem compared to other payment methods. This dominance provides a strong indication of market preference for credit cards due to the deferred payment mechanism that offers liquidity flexibility, so that consumers' instant cash flow is not disrupted when making large transactions. In addition, the advantages of credit cards are also reinforced by aggressive loyalty programs in the form of point accumulation, cashback, 0% interest installments in collaboration with the platform, as well as a multi-layered consumer protection system (buyer protection). This visual exploration provides an important initial foundation for understanding that digital payment platforms have become a crucial daily instrument for consumers, which will later be further examined in terms of their relation to transaction amounts in subsequent analysis.

Transaction Value Analysis Based on Payment Method

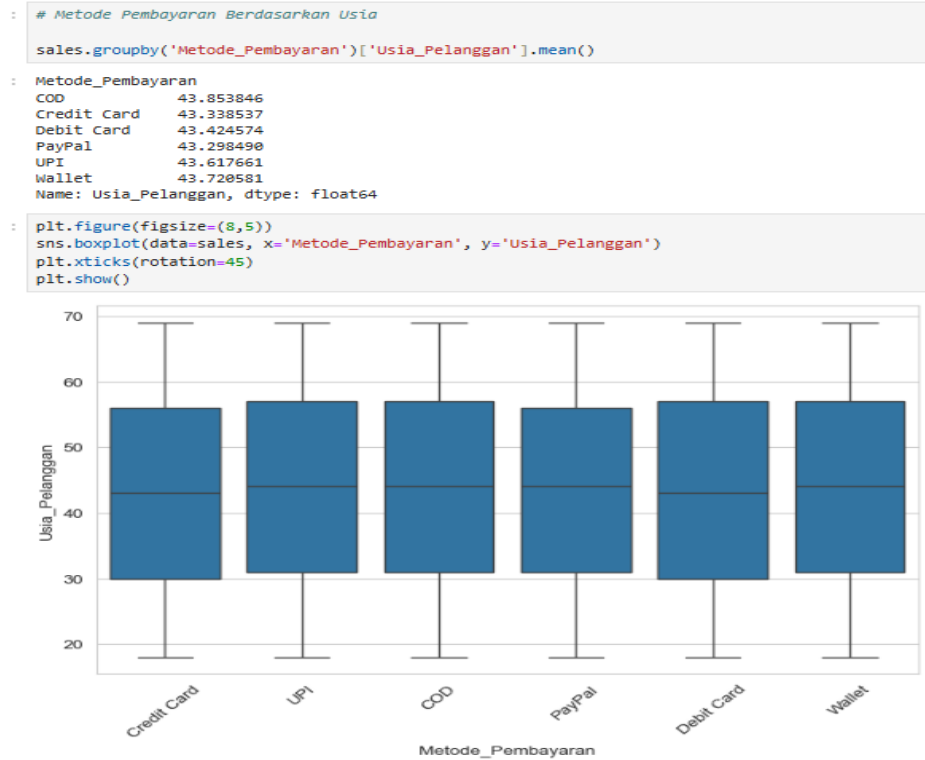


FIGURE 3. Boxplot Visualization

Based on the boxplot visualization in Figure 3, the distribution of transaction values for each payment method shows a relatively similar spread pattern. Nevertheless, payment methods such as Credit Card and PayPal show a wider range of transactions compared to other payment methods, indicating that these two methods are more often used for high-value transactions. In general, this visualization result shows that differences in payment methods do not directly result in extreme differences in consumer transaction values. This finding provides an initial indication that payment method preferences are more influenced by the convenience, flexibility, and accessibility of the payment system rather than the transaction purchase amount itself. Therefore, further statistical testing using ANOVA is needed to prove whether the differences in average transactions across payment methods are truly statistically significant.

Analisis Segmentasi Konsumen Berdasarkan Metode Pembayaran

Perbanas International Conference on Economics, Business, Management, Accounting and IT
(PROFICIENT) 2026
“Integrity-Driven Innovation: Reimagining Business, Finance, and Digital Transformation for Sustainable Impact”

Proceedings of the Perbanas International Seminar on Economics, Business, Management, Accounting and IT
[June 2026] [ISSN 3047-0951]

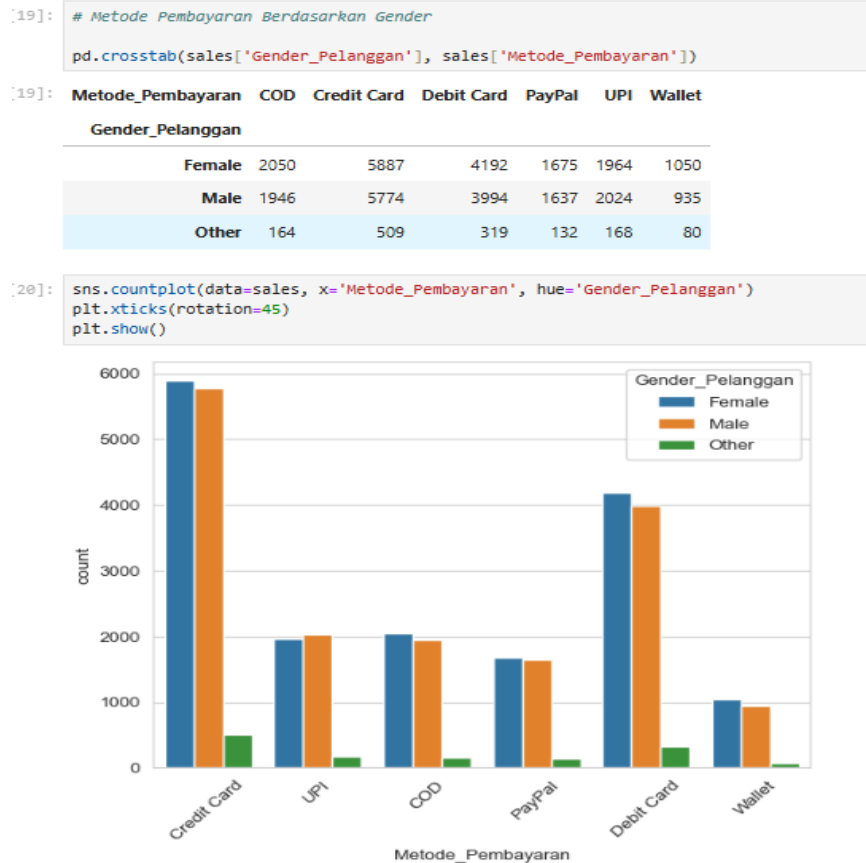


FIGURE 4. Distribution of Payment Methods by Gender

The distribution of payment method usage based on gender shows a relatively balanced pattern between male and female consumers. Credit Card has become the most widely used payment method by both gender groups, with the number of female users slightly higher compared to male users. Additionally, Debit Card payment methods also show a fairly high level of usage among both consumer groups.

For other digital payment methods such as UPI, PayPal, and Wallet, the number of male and female users also does not show a significant difference. Overall, this visualization indicates that the preference for payment methods tends to be evenly distributed among the main gender groups. These findings suggest that gender is not a dominant factor influencing the choice of payment method in e-commerce transactions.

Correlation Analysis

Correlation analysis is conducted to determine the relationship between numerical variables in the e-commerce transaction dataset. The variables analyzed include total transactions, profit margin, shipping costs, discounts, and delivery time. The results of the correlation matrix are visualized using a heatmap to facilitate identification of the strength of relationships between variables.

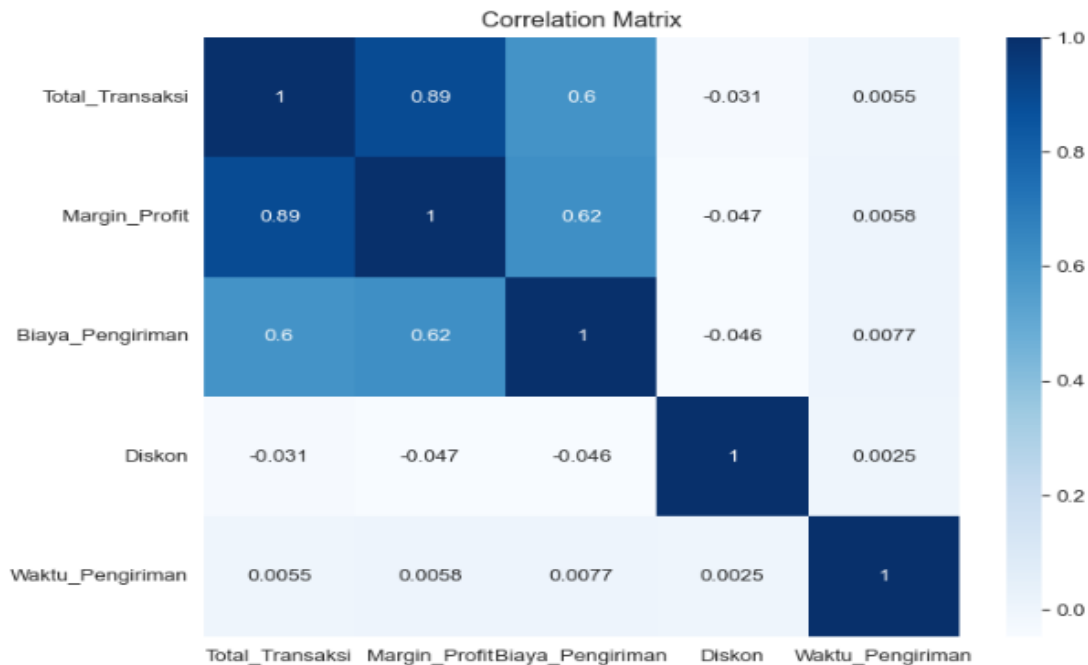


FIGURE 5. Correlation Matrix

Based on the visualization results of the correlation matrix in Figure 6, the Total_Transactions variable has a very strong positive relationship with Margin_Profit, with a correlation value of 0.89. These results indicate that the larger the transaction value made by consumers, the margin profit earned by the e-commerce platform also tends to increase significantly. This condition shows that the platform's profitability is highly influenced by the extent of consumer transaction activity.

In addition, the Total_Transactions variable also shows a fairly strong positive relationship with Shipping_Cost, with a correlation value of 0.60. These results indicate that transactions with higher values tend to have higher shipping costs. This can be caused by an increase in the number of products purchased, the size of the goods, or the use of certain shipping services in e-commerce transactions.

Meanwhile, the Discount variable shows a very low negative relationship with Total_Transactions, Profit_Margin, and Shipping_Cost. These results indicate that providing discounts in this research dataset does not have a significant impact on increasing transaction values or platform profitability. In addition, the Delivery_Time variable also shows a very low correlation with all other variables, so delivery time tends not to have a direct relationship with consumer transaction performance in the research dataset.

Overall, the results of the correlation analysis show that transaction and profitability factors have a more dominant relationship compared to promotion and delivery time factors in e-commerce activities. These findings provide insight that increasing consumer transaction activity has a direct impact on the profitability of digital platforms.

ANOVA Statistical Test

The use of statistical analysis such as correlation and ANOVA can help researchers identify variable relationships and measure the significance of differences between research groups (Ghozali, 2021). The use of ANOVA in this study aims to validate the results of the previous exploratory data analysis as well as to identify whether the payment method has an effect on transaction values in the e-commerce ecosystem.

```
from scipy.stats import f_oneway

cc = sales[sales['Metode_Pembayaran']=='Credit Card']['Total_Transaksi']
dc = sales[sales['Metode_Pembayaran']=='Debit Card']['Total_Transaksi']
cod = sales[sales['Metode_Pembayaran']=='COD']['Total_Transaksi']
upi = sales[sales['Metode_Pembayaran']=='UPI']['Total_Transaksi']
pp = sales[sales['Metode_Pembayaran']=='PayPal']['Total_Transaksi']

anova = f_oneway(cc, dc, cod, upi, pp)
print(anova)

F_onewayResult(statistic=np.float64(0.1657968949231055), pvalue=np.float64(0.9557882094810268))
```

Hasil uji ANOVA Anda menunjukkan:

- Nilai F-statistic = 0.1658
- Nilai p-value = 0.9558

FIGURE 6. ANOVA Test

The hypothesis used in the ANOVA test in this study is as follows:

- H_0 : There is no significant difference in the average transaction value between payment methods.
- H_1 : There is a significant difference in the average transaction value between payment methods.

Based on the ANOVA test results, an F-statistic value of 0.165 and a p-value of 0.955 were obtained. A p-value greater than the significance level of 0.05 indicates that H_0 is accepted and H_1 is rejected. Thus, it can be concluded that there is no significant difference in the average transactions among the payment methods used by consumers on the e-commerce platform.

These test results indicate that the payment method does not have a significant effect on the size of consumer transactions. This condition suggests that the choice of payment method is more influenced by factors such as convenience, ease of access, transaction security, usage flexibility, and payment promotions rather than the transaction amount itself.

The ANOVA results also reinforce the previous exploratory data analysis findings, which indicated that the transaction distribution for each payment method exhibits a relatively similar pattern.

V. CONCLUSION

This study aims to analyze the performance of digital payment systems within the e-commerce ecosystem using a comparative analysis approach through exploratory data analysis (EDA), correlation analysis, and ANOVA statistical tests. The study results indicate that digital payment methods have relatively similar transaction patterns and there are no significant differences in average transactions between payment methods based on ANOVA test results with a p-value of 0.955 (>0.05). Nonetheless, the Credit Card payment method remains the most dominant method used compared to other payment methods. This dominance is influenced by payment flexibility, ease of transactions for large amounts, cashback and reward programs, and higher transaction security levels. The study findings show that consumers tend to choose payment methods based on convenience and accessibility rather than transaction amount. This research still has limitations in using a single e-commerce transaction dataset, so future research can be developed using more complex machine learning approaches and customer segmentation to understand digital transaction behavior more deeply.

REFERENCES

- Chaffey, D., Hemphill, T., & Edmundson-Bird, D. (2019). *Digital business and e-commerce management* (7th ed.). Pearson UK.
- Ghozali, I. (2021). *Aplikasi analisis multivariate dengan program IBM SPSS*. Badan Penerbit Universitas Diponegoro.
- Hidayati, N., & Permana, R. (2024). Analisis kepuasan pengguna terhadap sistem pembayaran digital pada platform e-commerce. *Jurnal Informatika Ekonomi Bisnis*, 5(3), 120–129.
- Martadinata, A. T., & Zaliman, I. (2021). Perancangan dan implementasi sistem informasi e-commerce dengan menggunakan content management system (CMS), WooCommerce, dan Xendit pada koperasi Universitas Bina Insan. *Sigmata: Jurnal Manajemen dan Informatika*, 9(1), 16–21.
- Nugroho, A., & Ramadhani, F. (2023). Analisis pengaruh metode pembayaran digital terhadap loyalitas pelanggan e-commerce di Indonesia. *Jurnal Sistem Informasi dan Bisnis Digital*, 3(2), 71–82.
- Rahma, A. P. N. (2025). *Analisis kualitas sistem pembayaran digital: Studi komparasi antara TikTok Shop dan marketplace e-commerce lainnya di Indonesia* [Skripsi, Universitas Islam Indonesia].
- Rizkiyah, A., Windriyati, W., Qarinah, U., Izza, A. A., & Nugraha, B. S. P. (2024). Studi meta analisis pengaruh perilaku konsumen terhadap pembayaran digital. *AKSIOMA: Jurnal Sains Ekonomi dan Edukasi*, 1(8), 599–608. <https://doi.org/10.62335/zvrfzq81>
- Umam, L. A., & Bachtiar, F. (2024). Pengaruh penggunaan paylater terhadap perilaku impulse buying pengguna e-commerce di Indonesia. *Neraca: Jurnal Ekonomi, Manajemen dan Akuntansi*, 2(1), 245–249.