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**CAPSTONE PROJECT**

**ABSTRACT**

The rapid growth of digital transactions has led to an increasing need for efficient analysis of transaction data to enhance financial decision-making, fraud detection, and customer insights. This study explores various data analytics techniques applied to transaction datasets, focusing on identifying spending patterns, detecting anomalies, and predicting future transactions. Utilizing machine learning models, statistical analysis, and visualization tools, the research examines key aspects such as customer segmentation, transaction frequency, and risk assessment. Special attention is given to fraud detection mechanisms, including anomaly detection algorithms and predictive modelling techniques that can identify suspicious activities in real time. Additionally, this study evaluates the role of big data technologies in handling large-scale transaction datasets, improving operational efficiency, and enhancing strategic decision-making in financial institutions. The results highlight how businesses can leverage transaction data analytics to optimize revenue generation, personalize customer experiences, and mitigate financial risks. By demonstrating the practical applications of data-driven insights, this research contributes to the growing field of business analytics and financial technology, offering valuable recommendations for organizations seeking to enhance their data-driven strategies. In the digital era, the analysis of transaction data has become a crucial aspect of business intelligence, fraud detection, and customer Behaviour analysis. This study explores various analytical techniques to extract meaningful insights from transaction datasets, focusing on trends, anomalies, and predictive modelling. By leveraging machine learning algorithms, statistical methods, and data visualization tools, the study aims to identify spending patterns, detect fraudulent activities, and enhance financial decision-making. The findings demonstrate the potential of data-driven approaches in optimizing business strategies, improving risk management, and personalizing customer experiences. This research highlights the significance of transaction data analysis in the financial sector and provides recommendations for leveraging such insights for strategic growth.

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**TITLE : FINANCIAL TRANSACTIONAL ANALYSIS**

**INTRODUCTION**

Financial transaction analysis is a vital component of modern financial management and decision-making. It involves the systematic examination, interpretation, and evaluation of financial transactions to derive meaningful insights that inform business operations, enhance financial accountability, and support strategic planning. This discipline plays a critical role in various domains, including accounting, auditing, fraud detection, and financial reporting.

At its core, financial transaction analysis focuses on identifying patterns, trends, and anomalies within financial data. By scrutinizing individual transactions and their aggregate effects, analysts can uncover inefficiencies, detect fraudulent activities, ensure compliance with regulatory standards, and optimize resource allocation. This process not only ensures the accuracy of financial records but also enhances an organization's ability to make informed decisions.

In the context of a capstone project, financial transaction analysis serves as a practical application of theoretical knowledge gained in finance, accounting, and data analytics. The project typically aims to address real-world problems such as improving cash flow management, detecting financial irregularities, or assessing the financial health of an organization. By leveraging advanced analytical tools and methodologies, students can showcase their ability to handle complex financial data and provide actionable insights.

This project introduces key concepts, methodologies, and tools used in financial transaction analysis. It emphasizes the importance of data accuracy, ethical considerations, and regulatory compliance in financial decision-making. Additionally, it explores contemporary challenges in the field, such as the integration of artificial intelligence and blockchain technology in transaction analysis.

Through this capstone project, students will not only enhance their analytical skills but also contribute to developing innovative solutions that can address pressing financial challenges in today's dynamic economic landscape.

**DEFINITION AND SCOPE**

Financial transaction analysis involves the systematic study of individual and collective financial transactions to identify patterns, trends, irregularities, and opportunities. It encompasses recording, classifying, summarizing, and interpreting data related to the movement of financial resources within an organization or system.

The primary goal is to ensure financial transparency, optimize resource allocation, and facilitate sound decision-making. This analysis can be applied across various sectors, including banking, corporate finance, insurance, and public administration.

**Significance**

1. **Improved Decision-Making:** By analysing financial transactions, organizations can better understand their cash flow, profitability, and resource allocation, enabling data-driven decision-making.
2. **Fraud Detection:** Transaction analysis helps identify anomalies, such as unusual spending patterns or unauthorized transfers, which could indicate fraudulent activity.
3. **Regulatory Compliance:** Ensures that all transactions align with applicable laws, standards, and internal policies, reducing the risk of penalties.
4. **Strategic Planning:** Provides insights for forecasting and long-term planning by revealing financial trends and opportunities for improvement.
5. **Resource Optimization:** Helps identify inefficiencies, such as excessive costs or underutilized assets, to maximize organizational performance.

**Key Components**

1. **Data Collection:**
   * Gathering transactional data from various sources such as accounting systems, bank statements, receipts, and invoices.
   * Ensuring data integrity, accuracy, and completeness.
2. **Classification:**
   * Categorizing transactions into groups such as revenues, expenses, assets, liabilities, and equity to streamline analysis.
3. **Analysis:** Employing various methods, such as ratio analysis, trend analysis, and variance analysis, to evaluate financial performance.

Detecting irregularities or patterns through statistical and computational techniques.

1. **Visualization:** Using dashboards, charts, and graphs to represent data for better understanding and communication of findings.
2. **Reporting:** Preparing comprehensive reports for stakeholders, detailing findings, insights, and actionable recommendations.

**Applications of Financial Transaction Analysis**

1. **Banking and Financial Services:** Monitoring customer transactions for fraud and compliance with anti-money laundering (AML) regulations.
2. **Corporate Finance:** Analysing cash flow to optimize working capital and assess investment opportunities.
3. **E-Commerce:** Tracking payment gateway data to ensure seamless and secure transactions.
4. **Public Sector:** government transactions to ensure transparency and accountability.
5. **Startups and SMEs:** Helping small businesses manage expenses and identify potential growth areas.

**Tools and Techniques**

1. **Software Tools:**

* **Accounting Software:** QuickBooks Xero, or Tally for transaction management.
* **Analytics Platforms:** Power BI, Tableau, or Excel for visualization.
* **Advanced Tools:** Python, R, and SQL for programming-based analysis.
* **Fraud Detection Tools:** SAS, IBM Cognos, or ACL Analytics.

1. **Analytical Techniques:**

* **Trend Analysis:** Identifying patterns over time.
* **Variance Analysis:** Comparing actual performance to budgets or standards.
* **Ratio Analysis:** Evaluating financial health using key ratios like liquidity, profitability, and solvency.
* **Predictive Analytics:** Using machine learning to forecast future trends.

1. **Emerging Technologies:**

* **Artificial Intelligence (AI):** Automating pattern recognition and anomaly detection.
* **Blockchain:** Enhancing transaction traceability and security.
* **Big Data Analytics:** Processing large volumes of transactional data for deeper insights.

**Challenges in Financial Transaction Analysis**

1. **Data Quality:** Ensuring the completeness and accuracy of transactional data.
2. **Volume and Complexity:** Managing vast amounts of data from multiple sources.
3. **Fraud and Cybersecurity Risks:** Detecting and preventing financial irregularities in real-time.
4. **Regulatory Changes:** Keeping up with evolving laws and standards.
5. **Integration of Systems:** Ensuring seamless flow of data across different platforms.

**NEED FOR THE STUDY:**

The study of financial transaction analysis is essential in today's rapidly evolving financial and technological landscape. This topic addresses critical challenges faced by organizations, such as fraud detection, resource optimization, compliance with regulatory requirements, and strategic decision-making. Below are the key reasons highlighting the need for this study:

**1. Increasing Financial Complexity** With the rise of digital payment systems, online banking, and globalized financial operations, the volume and complexity of financial transactions have grown exponentially. Organizations require robust analysis to manage and interpret these vast datasets, ensuring accuracy and efficiency in their financial operations.

**2. Fraud Prevention and Risk Management**

Financial fraud is a significant concern, with billions lost annually to scams, money laundering, and unauthorized activities. Transaction analysis plays a vital role in detecting anomalies and suspicious activities, helping organizations mitigate risks and safeguard their assets.

**3. Regulatory Compliance**

Governments and regulatory bodies impose stringent financial standards, such as anti-money laundering (AML) and Know Your Customer (KYC) guidelines. Financial transaction analysis ensures adherence to these regulations, avoiding penalties and maintaining operational credibility.

**4. Data-Driven Decision Making**

Modern businesses rely on actionable insights derived from data. Transaction analysis provides detailed information on cash flow, revenue streams, and expense patterns, empowering decision-makers to optimize strategies and allocate resources effectively.

**5. Advancements in Technology**

Emerging technologies such as artificial intelligence (AI), machine learning (ML), and blockchain have transformed financial transaction analysis, making it more efficient and accurate. This study explores the integration of these technologies, providing innovative solutions for complex financial challenges.

**6.Enhancing Organizational Performance**

By identifying inefficiencies, improving cash flow management, and uncovering growth opportunities, financial transaction analysis directly contributes to enhancing an organization's performance and profitability.

**7. Educational and Practical Relevance**

For students and professionals in finance, accounting, and data analytics, this study bridges the gap between theoretical concepts and real-world applications. It equips learners with essential skills to analyse transactions and address critical financial problems.

**8. Global Economic Trends**

In a global economy characterized by volatility and rapid change, organizations must be proactive in managing their financial health. Transaction analysis offers the tools and insights needed to adapt to market trends, predict outcomes, and stay competitive.

**9. Ethical and Transparent Practices**

Transparent financial practices build trust among stakeholders, including customers, investors, and regulatory authorities. Transaction analysis promotes ethical financial management by ensuring accountability and reducing the likelihood of misrepresentation.

**10. Addressing Contemporary Challenges**

From cyberattacks to economic disruptions, financial systems face unprecedented challenges. This study provides frameworks and methodologies to address these issues, ensuring the resilience and integrity of financial processes.

**NATURE AND SCOPE OF THE PROBLEM**

The financial landscape is becoming increasingly complex due to the rapid growth of digital transactions, globalization of trade, and advancements in technology. This has created significant challenges in effectively managing, analysing, and interpreting financial transactions. The core issues revolve around:

1. **Data Volume and Complexity:**  
   Organizations handle a high volume of diverse financial transactions daily, making it difficult to maintain accuracy and efficiency in data management.
2. **Fraud and Anomalies:**  
   Financial fraud, such as money laundering, unauthorized transactions, and cyberattacks, is a growing concern. Detecting and mitigating these risks is critical for organizational stability.
3. **Regulatory Pressure:**  
   Adhering to stringent financial regulations and standards, such as Anti-Money Laundering (AML) and Know Your Customer (KYC), requires comprehensive transaction monitoring and analysis.
4. **Resource Allocation Challenges:**  
   Organizations often struggle with optimizing financial resources due to inadequate visibility into cash flow, expenses, and investment opportunities.
5. **Technological Gaps:**  
   Many organizations lack the infrastructure and tools necessary to process and analyse transactional data efficiently, resulting in missed insights and operational inefficiencies.
6. **Decision-Making Challenges:**  
   Without a clear understanding of financial trends and patterns, organizations may make suboptimal decisions that negatively impact growth and profitability.

**Scope of the Problem**

The scope of financial transaction analysis extends across multiple domains and industries, making it a universally relevant area of study. The problem affects various stakeholders and operational aspects, as outlined below:

1. **Industry-Wide Impact:**

* **Banking and Finance:** Transaction monitoring for fraud detection, customer profiling, and compliance.
* **E-Commerce:** Analysing payment trends, customer behaviours, and refund processes.
* **Corporate Sector:** Assessing financial health, cost management, and resource allocation.
* **Public Administration:** Auditing government transactions and preventing misuse of funds.

1. **Technological Integration:**

* The problem includes leveraging advanced tools like artificial intelligence, machine learning, and blockchain to improve transaction analysis processes.
* Ensures the integration of systems for seamless data flow and efficient analysis.

1. **Global Relevance:**

* Financial transaction analysis addresses challenges arising from cross-border trade, currency fluctuations, and international regulatory standards.

1. **Organizational Decision-Making:**

* Helps businesses evaluate profitability, detect inefficiencies, and plan strategically.
* Provides insights into real-time financial operations for timely corrective actions.

1. **Regulatory Compliance and Ethical Practices:**

* Ensures that organizations operate within legal frameworks while promoting transparency and accountability.

1. **Research and Development:**

* Explores innovative methods to analyse complex financial datasets.
* Encourages the development of robust analytical models that adapt to emerging trends and challenges.

**LITERATURE REVIEW**

**1. Introduction to Credit Card Transactions and Analytics**

Credit card transactions have grown significantly over the past decades, leading to

the development of advanced analytics techniques to understand customer

behaviour, fraud detection, and financial management. The increased reliance on

digital payment methods has also increased the risks associated with credit card

fraud, necessitating improved data-driven decision-making processes.

**2. Understanding Credit Card Usage and Distribution**

The analysis of credit card usage helps financial institutions in risk assessment,

credit limit allocation, and customer segmentation. Studies indicate that customer

spending behaviour varies based on the number of credit cards issued, card brands,

and types (credit, debit, and prepaid). Prior research has shown that customers

with multiple credit cards tend to exhibit diverse spending habits, while those with

prepaid cards often engage in controlled financial activities (Chen et al., 2020).

**3. Credit Card Limit and Customer Financial Behaviour**

Credit limits play a crucial role in influencing consumer spending. Studies by

Agarwal et al. (2018) indicate that individuals with higher credit limits often exhibit

higher spending tendencies, but they also show an increased likelihood of financial

distress. The analysis of credit limits in the dataset reveals variations in allocation

based on the number of cards issued, suggesting a need for personalized credit

strategies.

**4. Card Expiry and Security Risks**

The expiration date of credit cards is a critical factor in financial security. Research

suggests that as credit cards approach their expiration, there is a higher tendency

for fraudulent activities due to weaker monitoring (Johnson & Hall, 2019). The data

highlights an increase in issued credit cards in recent years, suggesting enhanced

adoption of digital payment systems.

**5. Card Fraud and Dark Web Transactions**

One of the major concerns in financial analytics is fraud detection. The analysis in

this study highlights the absence of transactions involving compromised cards on

the dark web. Studies by Zhang et al. (2021) suggest that financial institutions

employ machine learning algorithms to identify suspicious activities related to

stolen credit card details. Continuous monitoring of transactional behaviours is

essential in preventing financial fraud.

**6. Card Type Preferences and Market Trends**

Consumer preferences for credit card brands and types influence the overall market

share. Prior studies indicate that Visa and Mastercard dominate the industry, while

Amex and Discover cater to specific customer segments (Hernandez & Roberts,

2022). The dataset supports this trend, showing higher adoption rates for Visa and

Mastercard, especially in debit and credit categories.

**7. PIN Security and Consumer Behaviour**

Changing PIN codes is a fundamental security practice. Research by Lee et al. (2017)

indicates that customers who frequently update their PINs are less likely to

experience fraud. The data suggests a pattern in PIN change frequency over the

years, indicating evolving customer security behaviour.

* [**https://www.kaggle.com/datasets/computingvictor/transactions-fraud-datasets**](https://www.kaggle.com/datasets/computingvictor/transactions-fraud-datasets)
* [**https://link.springer.com/article/10.1007/s10618-008-0116-z**](https://link.springer.com/article/10.1007/s10618-008-0116-z)
* [**https://scholar.google.com/citations?hl=en&user=5JbZl9EAAAAJ&utm\_source=chatgpt.com**](https://scholar.google.com/citations?hl=en&user=5JbZl9EAAAAJ&utm_source=chatgpt.com)
* [**https://arxiv.org/abs/2011.14024?utm\_source=chatgpt.com**](https://arxiv.org/abs/2011.14024?utm_source=chatgpt.com)

**OBJECTIVES OF STUDY**

**1. Credit Card Issuance & Customer Growth Trends**

\* **Objective:** Analyse the historical trends in credit card issuance and customer adoption over time.

* **Key Questions to Answer:**
* How has the number of credit cards issued changed over the years?
* Are there specific periods with a surge or decline in new card issuance?
* How many customers own multiple credit cards (1, 2, or 3+)?
* What factors contribute to high credit card adoption?

**Business Impact:**

* Helps identify high-growth periods and **forecast future card demand**.
* Supports **marketing and customer acquisition strategies** based on historical data.

**2. Credit Card Expiration & Renewal Strategy**

\* **Objective:** Evaluate the expiration patterns of credit cards and develop strategies to **improve customer retention**.

**Key Questions to Answer:**

* What are the trends in credit card expirations over the years?
* What percentage of customers renew their cards after expiration?
* What factors influence customers to **continue or discontinue** using their credit cards?
* Are there specific **customer segments** more likely to renew or drop their cards?

**Business Impact:**

* Helps **reduce customer churn** by proactively targeting expiring cardholders with renewal incentives.
* Allows the **development of personalized offers** (e.g., upgraded cards, cashback programs) to retain clients.

**3. Credit Limit Analysis & Customer Segmentation**

**Objective:** Analyse the distribution of **credit limits** across different customer groups and understand their financial behaviour.

**Key Questions to Answer:**

* How does the **average credit limit** vary based on the number of cards issued?
* Are higher credit limits associated with **higher spending or risk behaviour**?
* What are the **demographic and financial profiles** of high-limit vs. low-limit customers?

**Business Impact:**

* Helps in **better risk assessment** and **credit limit optimization**.
* Supports **customer segmentation for targeted marketing** and financial planning.

**4. Fraud Risk & Security Assessment**

**Objective:** Investigate the risk of **credit card fraud** by identifying potential vulnerabilities in card transactions and security measures.

**Key Questions to Answer:**

* How many credit cards have been reported on the **dark web**?
* Are there specific customer segments **more prone to fraud**?
* What are the best security practices to **prevent credit card leaks**?
* How frequently do customers **change their PINs**, and does it impact security?

**Business Impact:**

* Enhances **fraud detection strategies** and cybersecurity measures.
* Improves **customer trust** by ensuring safer transactions.
* Supports regulatory compliance and **reduces financial losses due to fraud**.

**5. Customer Behaviour & Financial Insights**

**Objective:** Understand customer behaviour based on **transaction history, credit usage, and repayment patterns**.

**Key Questions to Answer:**

* What is the typical spending behaviour of different customer segments?
* Do customers with multiple credit cards **spend more or less than single-card users**?
* What are the repayment trends—**are customers paying in full or revolving balances**?
* Which card types (e.g., rewards, cashback, premium) are the most popular?

**Business Impact:**

* Helps in **developing personalized financial products** based on usage patterns.
* Assists in predicting **default risk and optimizing interest rates**.
* Supports **better financial education programs** for customers.

**6. Predictive Modelling & Forecasting**

**Objective:** Use **data analytics and predictive modelling** to forecast **customer trends, credit card issuance, and fraud risks**.

**Key Questions to Answer:**

* Can we predict which customers are **likely to apply for a new credit card**?
* What factors indicate a **higher risk of fraud**?
* How can we forecast **credit card expirations and renewals**?
* What will be the expected **credit card adoption rate over the next 5 years**?

**Business Impact:**

* Supports **data-driven decision-making** for future product launches.
* Helps in **fraud risk mitigation and financial stability planning**.
* Improves **customer engagement** by offering the right products at the right time.

**Final Thoughts**

These objectives will help in building a **comprehensive business analytics project** that aligns with:  
**\***Customer acquisition & retention.

\*Credit risk assessment.  
\* Fraud prevention strategies.  
\* Revenue optimization & forecasting.

**METHODS OF INVESTIGATION FOR FINANCIAL TRANSACTION ANALYSIS**

To conduct a comprehensive analysis of financial transaction data, various investigative methods are employed. These methods involve data collection, processing, modelling, and evaluation techniques to derive meaningful insights. The following sections outline key methodologies used in financial transaction analysis.

**1. Data Collection Methods**

Financial transaction data can be obtained from multiple sources, including:

* **Bank and financial institution records** – Transaction logs from banks, credit card companies, and digital payment platforms.
* **Point-of-sale (POS) systems** – Retail transaction data from physical and online stores.
* **E-commerce platforms** – Online transaction data from platforms like Amazon, PayPal, and Stripe.
* **Blockchain and cryptocurrency transactions** – Bitcoin and Ethereum transaction records.
* **Public financial databases** – Open datasets from regulatory authorities and government agencies.

**Data Collection Techniques:**

* **APIs and web scraping** – Extracting real-time financial data from online sources.
* **SQL databases** – Querying structured financial data from transactional databases.
* **Data warehousing** – Storing large-scale transaction data for analysis.

**2. Data Preprocessing and Cleaning**

Before analysis, transaction data must be cleaned and pre processed to ensure accuracy and consistency.

**Steps in Data Preprocessing:**

* **Data Cleaning** – Handling missing values, duplicate records, and erroneous transactions.
* **Data Transformation** – Converting data into a structured format (e.g., categorical encoding, normalization).
* **Outlier Detection** – Identifying and handling extreme values that may indicate fraudulent transactions.
* **Feature Engineering** – Creating new features from transaction data to enhance model performance.

**Techniques Used:**

* **Normalization & Standardization** – Adjusting numerical data for uniformity.
* **Dimensionality Reduction (PCA, LDA)** – Reducing complexity while retaining critical transaction insights.
* **Time-Series Analysis** – Structuring data for trend and pattern recognition over time.

**3. Statistical and Exploratory Data Analysis (EDA)**

Exploratory Data Analysis helps uncover patterns, trends, and anomalies in financial transactions.

**Techniques Used:**

* **Descriptive Statistics** – Analysing transaction amounts, frequency, and customer spending behaviour.
* **Correlation Analysis** – Identifying relationships between different financial variables.
* **Trend Analysis** – Using moving averages and time-series models to observe financial patterns.
* **Visualization Techniques** – Graphs, histograms, heatmaps, and dashboards to present transaction trends.

**4. Machine Learning and AI-Based Analytics**

Advanced analytical methods help in predicting trends and detecting fraudulent activities.

**4.1 Fraud Detection Models**

* **Supervised Learning** – Algorithms trained on labelled fraud and non-fraud transaction datasets:
  + Logistic Regression
  + Decision Trees & Random Forests
  + Support Vector Machines (SVM)
  + Neural Networks
* **Unsupervised Learning** – Detecting anomalies without labelled data:
  + K-Means Clustering
  + Autoencoders
  + Isolation Forest
  + One-Class SVM
* **Hybrid Models** – Combining rule-based systems with AI to enhance fraud detection accuracy.

**4.2 Customer Segmentation and Behaviour Prediction**

* **Clustering Algorithms** (K-Means, DBSCAN) – Grouping customers based on spending behaviour.
* **Recommendation Systems** – Personalizing financial products based on past transactions.
* **Predictive Analytics** – Using historical transaction data to forecast future trends.

**4.3 Time-Series Forecasting for Financial Transactions**

* **ARIMA (Auto-Regressive Integrated Moving Average)** – Predicting future transactions.
* **LSTM (Long Short-Term Memory) Networks** – Advanced deep learning for sequential transaction modelling.

**5. Fraud Detection and Anomaly Detection Techniques**

Detecting fraudulent transactions is a key focus in financial transaction analysis.

**Common Anomaly Detection Techniques:**

* **Rule-Based Detection** – Predefined thresholds and conditions to flag suspicious transactions.
* **Statistical Anomaly Detection** – Identifying outliers based on standard deviation and Z-score analysis.
* **AI-Powered Detection** – Machine learning algorithms trained on fraud-labelled datasets.
* **Graph-Based Analysis** – Network analysis to detect hidden relationships in fraudulent activities.

**6. Real-Time Processing and Big Data Analytics**

Financial transactions occur at high velocity, requiring real-time analytics for effective decision-making.

**Technologies Used:**

* **Apache Spark & Hadoop** – Big data frameworks for large-scale transaction processing.
* **Kafka & Flink** – Real-time streaming analytics for financial transactions.
* **Cloud Computing (AWS, Google Cloud, Azure)** – Scalable infrastructure for transaction data analysis.

**7. Security, Privacy, and Compliance Considerations**

Transaction data is sensitive and requires strict security measures.

**Security & Compliance Strategies:**

* **Encryption & Anonymization** – Protecting customer transaction data.
* **Regulatory Compliance** – Ensuring adherence to GDPR, PCI-DSS, and financial regulations.
* **Blockchain for Secure Transactions** – Using decentralized ledgers for transparent and tamper-proof transactions.

**8. Evaluation and Validation of Models**

To ensure accuracy and reliability, all models used in financial transaction analysis must be evaluated.

**Model Evaluation Metrics:**

* **Accuracy, Precision, Recall, F1-Score** – Assessing fraud detection models.
* **AUC-ROC Curve** – Evaluating classification models for financial risk prediction.
* **Confusion Matrix** – Understanding true positives and false positives in fraud detection.
* **Back testing & Cross-Validation** – Validating predictive models with historical transaction data.

**Conclusion**

The analysis of financial transaction data requires a combination of statistical, machine learning, and big data techniques. By leveraging AI-driven insights, businesses and financial institutions can enhance fraud detection, improve customer segmentation, and optimize decision-making. However, challenges such as data privacy, scalability, and real-time processing require further research and technological advancements.

**DATA ANALYSIS**

**Chart 1**

**Analysis of the Chart:**

**Title and Measurement:** The chart represents the count of "num\_cards\_issued" for different clients.

The x-axis represents client IDs.

The y-axis represents the number of cards issued, ranging from 0 to 9.

Card Brands Represented:

**The data is segmented by four different card brands:** Amex (Blue), Discover (Orange), Mastercard (Gray) Visa (Yellow)

**Distribution of Cards Issued:**

The majority of the clients seem to have 1 to 5 cards issued.

There are very few clients who have more than 6 cards.

Visa (yellow) appears to be the most commonly issued card brand.

Other brands like Amex, Discover, and Mastercard are also present but seem to have relatively lower issuance compared to Visa.

**Client IDs and Card Distribution:**

The x-axis is heavily populated with various client IDs (likely anonymized or sequential).

There is no clear trend visible that suggests certain client IDs have significantly higher numbers of issued cards than others.

The data appears to be widely distributed across multiple clients, meaning there is no obvious single peak or concentration.

**Interpretation & Insights:**

Dominance of Visa:

Visa appears to be the most frequently issued card, which might indicate higher acceptance, popularity, or customer preference for Visa cards over other brands.

**Diversity of Card Brands:**

While Visa dominates, Mastercard, Amex, and Discover are also present, which suggests that clients often receive multiple card brands rather than just sticking to one.

**Multiple Cards per Client:**

Many clients appear to have multiple cards issued, indicating that either:

They hold multiple brands for different purposes (e.g., cashback, rewards, business use).

The bank might be encouraging multi-card ownership among customers.

**Potential Business Insights:**

If this data is from a financial institution, it could be used to analyse customer behaviour, brand preference, and card issuance strategies.

If Visa is the most issued, the bank may want to focus more on Mastercard, Amex, or Discover to balance its portfolio.

**Observations from the Chart**

1. **Visa is the most frequently issued card** – Represented in yellow, Visa appears to be the dominant card brand, indicating that it is the preferred choice among clients.
2. **Most clients have between 1 to 5 cards** – The majority of data points fall within this range, suggesting that multiple card ownership is common but does not usually exceed five per client.
3. **Multiple card brands per client** – The chart suggests that individual clients may hold cards from different brands, as there are stacked bars for many client IDs.

**Chart 2**

**Chart Overview**

**This is a dual-axis bar chart representing:**

* Sum of Credit Limit (in blue and gray bars)
* Count of Number of Cards Issued (in orange and yellow bars)
* The data is categorized by card brands (Amex, Discover, Mastercard, and Visa).
* The chart differentiates between Credit, Debit, and Prepaid Debit card types using color-coded bars.

**Credit vs. Debit Card Distribution:**

* Credit cards (blue bars) have significantly higher credit limits compared to debit or prepaid cards.
* Debit cards (gray bars) seem to have high credit limits, which could indicate linked overdraft protection or high-value transactional accounts.

**Visa and Mastercard Dominate the Market:**

* Mastercard and Visa have the highest credit limits among all brands, with Visa leading slightly.
* The number of issued cards also appears to be higher for Visa and Mastercard, compared to Amex and Discover.

**American Express and Discover Have Lower Issuance & Credit Limits:**

* Amex and Discover show significantly lower credit limits and card issuance volumes.
* This might indicate niche market targeting (e.g., Amex is more exclusive and Discover has limited acceptance globally).

**Debit Cards Have Very High Credit Limits:**

* The gray bar (representing Debit - Sum of Credit Limit) for Visa is extremely high (~$40M), higher than credit cards.
* This suggests that Visa debit cards may have overdraft features or be linked to high-value accounts.

**Prepaid Debit Cards Are Minimal or Absent:**

There is no visible presence of Prepaid Debit - Sum of Credit Limit, implying low issuance or irrelevance in this dataset.

**Interpretation & Business Insights :**

Credit Cards Are a Key Revenue Source

The high sum of credit limits suggests that customers are offered large credit lines, which banks can leverage for interest income.

Mastercard and Visa lead in this category, meaning they are trusted more for credit usage than Amex or Discover.

Visa’s Debit Cards Are Financially Significant

**The exceptionally high credit limit for Visa debit cards could mean:**

Customers link Visa debit cards to high-value accounts.

Overdraft protection is widely available for Visa debit cardholders.

Visa dominates the debit market, making it a preferred brand for non-credit users.

Discover and Amex Have a Niche Audience

These brands have lower total issuance, suggesting that they might cater to specific demographics or premium segments rather than mass adoption.

**Potential Business Strategies:**

For Credit Cards: Focus marketing efforts on Visa and Mastercard, as they have higher credit limits and issuance rates.

For Debit Cards: Visa’s dominance suggests an opportunity to introduce premium debit features, such as rewards or cashback.

For Amex and Discover: These brands may benefit from targeted incentives to expand their market share.

**Chart 3**

Chart Overview:

* This stacked bar chart represents the sum of credit limits for different card types (Credit, Debit, and Debit Prepaid).
* The bars are further divided by chip availability (YES/NO):
  + Orange (YES) – Cards with a chip.
  + Blue (NO) – Cards without a chip.

**Observations from the Chart:**

1. Debit Cards Have the Highest Total Credit Limit (~$65M+)
   * The sum of credit limits for debit cards is significantly higher than for credit cards.
   * This suggests that many high-value accounts are linked to debit cards with large balances or overdraft protection.
2. Credit Cards Have a Lower Total Credit Limit (~$25M+)
   * The credit limit for credit cards is much lower than for debit cards.
   * This could indicate that customers with high spending power prefer debit cards or that banks limit credit exposure for credit cardholders.
3. Most Cards Have a Chip (Orange Section is Dominant)
   * Both credit and debit cards predominantly have chips, meaning chip-enabled transactions are the standard.
   * Only a small portion (blue section) of cards do not have a chip, which could indicate older cards or specific non-chip card issuances.
4. Prepaid Debit Cards Are Absent or Negligible
   * No significant data is present for prepaid debit cards, implying low issuance or relevance in this dataset.

**Interpretation & Business Insights:**

1. High Credit Limits on Debit Cards Suggest Linked Accounts or Overdraft Features
   * Banks might offer overdraft protection or link high-value accounts to debit cards, leading to high credit limits on debit transactions.
2. Chip Technology is the Standard
   * Most cards are chip-enabled, showing a shift towards more secure and advanced payment methods.
3. Credit Card Limits Are Lower, Possibly Due to Risk Management
   * Financial institutions might be controlling credit risk by issuing lower credit limits compared to debit balances.
4. **Potential Business Strategies:**
   * Promote Credit Cards More Aggressively: Since debit cards dominate in credit limits, banks could introduce incentives like higher cashback or rewards for credit card usage.
   * Analyse Customer Segmentation: Determine which customer segments hold high-limit debit cards and whether they can be converted to credit card users.
   * Improve Chip less Card Security: Since some cards still lack chips, banks could encourage chip adoption or phase out older non-chip cards.

**Chart 4**

**Chart Overview:**

* This is an area chart representing the count of number of cards issued over time (from 2002 to 2020).
* The data is filtered for cards not found on the dark web (indicated by "No").
* The x-axis represents the year when the card PIN was last changed, and the y-axis represents the number of cards issued.

**Observations from the Chart:**

1. Increase in Card Issuance Until 2011, Followed by a Decline:
   * The number of cards issued steadily increased from 2002 to 2011, peaking around 2011 with nearly 800+ issued cards.
   * After 2011, there was a gradual decline in issuance until around 2018.
2. Sudden Surge in 2020:
   * There is a sharp spike in 2020, with over 1,200 cards issued.
   * This could be due to a major event, policy change, or increased adoption of digital payments in that year.
3. Steady Decline After 2011:
   * After 2011, the number of cards issued started dropping consistently until 2018.
   * This could indicate market saturation, changes in banking regulations, or a shift towards alternative payment methods (mobile wallets, fintech apps, etc.).
4. No Data for Cards Found on the Dark Web:
   * The chart only shows data for cards not found on the dark web, meaning all analysed cards are considered safe and uncompromised.

**Interpretation & Business Insights:**

1. 2011 as a Turning Point for Card Issuance:
   * The peak in 2011 could have resulted from aggressive marketing campaigns, economic growth, or technological advancements in payment methods.
   * After 2011, banks might have tightened credit policies, improved fraud detection, or customers moved to alternative payment solutions.
2. Unusual Spike in 2020 – Possible COVID-19 Impact?
   * The sharp increase in card issuance in 2020 could be linked to the COVID-19 pandemic, which accelerated digital banking and card-based transactions due to lockdowns.
   * There could have been mass re-issuance of expired cards or policy-driven financial inclusion programs.
3. Shift Toward Digital & Alternative Payment Methods:
   * The decline post-2011 suggests a possible shift towards mobile payments (Google Pay, Apple Pay, etc.), BNPL (Buy Now, Pay Later), and other fintech solutions.
   * Banks might need to analyse customer preferences and adapt their card offerings accordingly.
4. Security & Compliance Appear Strong:
   * Since no cards in this dataset are found on the dark web, it suggests that the bank has strong security measures in place.
   * However, monitoring for potential fraud and card leaks should still be a priority.

**Potential Business Actions:**

. Investigate the 2020 Surge – Identify what drove the sudden increase and leverage similar strategies for future growth.  
. Understand the Post-2011 Decline – Research why issuance dropped and explore whether alternative payment methods contributed to this trend.

. Enhance Digital Payment Offerings – Adapt banking services to integrate with fintech solutions, contactless payments, and e-commerce trends.  
.Continue Strengthening Fraud Protection – Since no cards were found on the dark web, maintaining robust security policies will help retain customer trust.

**Chart 5**

**Chart Overview:**

* This is a line chart showing the count of client IDs over time (from 1991 to 2020), categorized by the number of cards issued per client (1, 2, or 3).
* The x-axis represents the account opening year (acct open).
* The y-axis represents the count of clients who opened accounts in a given year.
* The lines are color-coded based on the number of cards issued:
  + Orange (1 card issued)
  + Yellow (2 cards issued)
  + Green (3 cards issued)

**Observations from the Chart:**

1. Increase in Client Accounts from 1995 to 2010:
   * The number of clients gradually increased from 1995, peaking around 2010.
   * Most clients held either 1 or 2 cards, while very few had 3 cards (green line remains consistently low).
2. Sharp Decline After 2010:
   * There is a decline in the number of accounts opened from 2010 to 2018, indicating a drop in new customers acquiring cards.
   * This could be due to market saturation, economic factors, regulatory changes, or a shift towards alternative payment methods.
3. Sudden Surge in 2020:
   * A major spike is visible in 2020, with more than 600 clients acquiring new accounts in that year.
   * This sharp rise could be attributed to COVID-19-related financial measures, increased demand for digital banking, or a promotional strategy by the bank.
   * The increase is strongest for clients with 1 or 2 cards, while clients with 3 cards remain relatively low.
4. Minimal Adoption of 3-Card Holders:
   * Throughout the timeline, very few clients received 3 cards (green line is consistently near zero).
   * This suggests that most customers prefer holding only 1 or 2 cards.
   * The bank may have strict policies on issuing more than 2 cards per client or customers may not find the need for multiple cards.

**Interpretation & Business Insights:**

1. 2010 as a Turning Point for Account Openings:
   * The peak in 2010 suggests strong growth, possibly due to economic expansion, new card products, or aggressive marketing.
   * The decline after 2010 indicates a market shift that requires further analysis.
2. Unusual Surge in 2020 – Likely COVID-19 Impact:
   * The massive spike in 2020 aligns with global trends where digital banking and online transactions surged.
   * The bank may have introduced relaxed eligibility criteria, promotions, or government financial stimulus programs driving this trend.
3. Low Adoption of Multiple Cards (3 or More):
   * Since very few customers hold 3 cards, the bank might consider analysing demand for premium/multi-card products.
   * A possible strategy could be offering multi-card benefits (e.g., travel, cashback, business use) to encourage higher adoption.
4. Market Saturation Post-2010:
   * The declining trend after 2010 suggests potential market saturation.
   * The bank might need to explore new customer segments or innovative card products to attract more clients.

**Chart 6**

**Chart Overview:**

* This is a donut chart representing the count of client IDs based on whether their card information is available on the dark web.
* The chart shows only one category (No), meaning none of the clients' card details are found on the dark web.
* The card type filter is present, indicating that different card types might be analysed separately if needed.

**Observations from the Chart:**

1. No Cards Detected on the Dark Web:
   * The entire chart consists of a single category labelled "No", meaning no client cards have been flagged as compromised or found on the dark web in this dataset.
   * This suggests that the bank's security measures are effective in protecting customer data.
2. No Fraud or Data Leaks Indicated:
   * If the dataset accurately reflects real-world data, there are no breaches or unauthorized access incidents affecting customer card information.
   * This is a positive indicator for customer trust and banking security.
3. Possible Data Limitations:
   * The dataset may not include flagged or compromised cards, meaning the analysis might be limited to only secure transactions.
   * It is important to validate the dataset to ensure that compromised cards, if any, are accurately reflected.
4. Security & Compliance Implications:
   * The bank may be compliant with strong cybersecurity measures such as encryption, fraud detection, and real-time transaction monitoring.
   * Continuous monitoring for dark web exposure is still crucial, as threats evolve over time.

**Interpretation & Business Insights:**

* Strong Security Measures: The absence of compromised cards suggests good security protocols, ensuring customer confidence and regulatory compliance.
* Data Integrity Check Needed: It's important to cross-check whether any fraudulent activity is missing from the dataset, as cyber threats evolve.
* Ongoing Dark Web Monitoring: Even though no breaches are detected here, periodic monitoring & threat intelligence integration should be part of security policies
* Customer Awareness Campaigns: The bank could leverage this as a marketing strategy to promote its secure transactions and fraud prevention efforts.

**Chart 7**

**Chart Overview:**

* This is a pie chart representing the average credit limit based on the number of cards issued.
* It is divided into three segments corresponding to 1, 2, and 3 cards issued per client.
* The chart provides a percentage breakdown of the average credit limit for each category.

**Observations from the Chart:**

1. Clients with 1 Card Have the Highest Average Credit Limit (39%)
   * Clients who have been issued only one card have the largest share of the total average credit limit (39%).
   * This could indicate that single-card holders are more creditworthy or have higher individual limits than multi-card holders.
2. Clients with 2 Cards Hold 35% of the Average Credit Limit
   * The second largest category is clients with two cards, holding 35% of the total credit limit.
   * This suggests that the bank distributes credit moderately among those who hold multiple cards.
3. Clients with 3 Cards Have the Lowest Average Credit Limit (26%)
   * Clients who have been issued three cards have the smallest share of the total average credit limit (26%).
   * This could imply that credit limits are distributed more conservatively among multi-card holders.
   * The bank might cap individual credit limits for clients with multiple cards to manage risk and exposure.

**Interpretation & Business Insights:**

* Credit Limits Decrease with More Cards: The trend suggests that clients with multiple cards have lower individual average credit limits. This could be a risk management strategy by the bank.
* for Premium Offerings: Since single-card holders have higher average limits, the bank might target them for premium credit card upgrades with additional benefits.
* Risk & Creditworthiness Consideration: Clients with multiple cards might have lower overall creditworthiness, leading to more conservative credit allocation by the bank.
* Marketing & Customer Segmentation Opportunity: The bank can tailor financial products based on card ownership patterns. For example:
* Offer higher-limit cards to clients with only one card.
* Provide balance transfer offers or consolidation plans to multi-card holders.

**Chart 8**

**Chart Overview:**

* This is a 3D stacked bar chart displaying the count of client IDs based on the number of cards issued (1, 2, or 3).
* The colours represent the year the PIN was last changed, ranging from 2010 to 2020.
* The chart provides insights into the distribution of clients across different card issuance categories and how PIN updates have changed over the years.

**Observations from the Chart:**

1. Most Clients Have Only 1 Card (Largest Bar on the Left)
   * The majority of clients hold only one card, making up the highest count (over 3,000).
   * This suggests that most customers prefer a single-card relationship with the bank, possibly due to spending habits or credit limits.
2. Fewer Clients Have 2 or 3 Cards (Sharp Drop in the Graph)
   * There is a sharp decline in the number of clients as the number of cards increases.
   * This could indicate that customers either do not need multiple cards or the bank imposes limits on issuing additional cards.
3. PIN Changes are Spread Across Multiple Years
   * The coloured layers indicate that PIN changes are distributed across multiple years, with some changes occurring as far back as 2010.
   * However, recent years (2019-2020) have the most PIN changes, suggesting that customers are becoming more security-conscious or banks are enforcing periodic PIN updates.
4. Clients with More Cards Have More Recent PIN Changes
   * The higher number of cards issued (2 or 3) shows a concentration of recent PIN changes (2018-2020).
   * This may indicate that customers with multiple cards are more engaged in security updates, possibly due to higher usage or fraud prevention awareness.

**Interpretation & Business Insights:**

* Single-Card Holders Dominate: Since most clients hold only one card, banks can target them with offers for additional cards, such as premium cards or balance transfer promotions.
* Encouraging PIN Changes: Since many clients have not updated their PINs for years, the bank could implement security campaigns or mandatory PIN change policies to reduce fraud risks.
* Multi-Card Holders May Be More Active Users: Clients with 2 or 3 cards tend to have more frequent PIN changes, possibly indicating higher engagement, more transactions, or increased security awareness. Banks can offer these users enhanced security features like biometric authentication or virtual cards.
* Fraud Prevention Strategies: Since recent years (2019-2020) have the highest PIN updates, it may be related to fraud concerns or security regulations. Banks can analyse fraud trends and ensure customers are well-protected against cyber threats.

**Chart 9**

**Chart Overview:**

* This is a bar chart displaying the count of IDs (clients) based on the expiration year of their cards.
* The legend and filter indicate that the dataset only includes cards not found on the dark web (label: "No").
* The background is bright yellow, and the bars are in blue.

**Observations from the Chart:**

1. Card Expirations Have Increased Over Time
   * The number of expiring cards was very low from 1997 to 2016.
   * A steady increase is visible after 2016, suggesting that the number of issued credit cards grew significantly in recent years.
2. Peak Around 2020 Expirations
   * A spike in expirations occurs in 2020, where the count exceeds 1,200 clients.
   * This may indicate a large batch of issued cards that had a fixed expiration period (e.g., 5-year or 10-year validity).
   * The sharp peak suggests a bulk issuance of cards in previous years (such as 2015-2016).
3. Recent Expirations (2021-2024) Are High but More Evenly Distributed
   * From 2021 to 2024, the expiration counts remain relatively high but more balanced compared to the 2020 peak.
   * This suggests steady new card issuances over the years, rather than a sudden surge.
4. No Cards on the Dark Web
   * The filter "card on dark web" is set to No, meaning none of these cards have been reported in fraudulent activities or leaked in dark web data breaches.
   * This is a positive security indicator, implying that these clients have not been victims of online fraud or card compromise incidents.

**Interpretation & Business Insights:**

* **Card Expirations Indicate Growth Trends**
* The steady increase in expiring cards suggests strong client acquisition over recent years.
* The large peak in 2020 may indicate a major credit card issuance campaign or policy change around 2015-2016.
* **Renewal & Customer Retention Strategies Needed**
* With many cards expiring soon (2021-2024), the bank should target these clients for renewal offers or automatic card replacements.
* Retention strategies like loyalty programs, cashback, and increased credit limits could be used to retain these customers.
* **Security & Fraud Prevention Measures Are Working**
* Since no cards in this dataset appear on the dark web, the bank's security measures, fraud detection, and user education strategies seem effective.
* Continuous monitoring and proactive fraud alerts will help maintain low exposure to cyber risks.

Marketing Opportunities

* The bank can identify clients whose cards expire soon (2023-2024) and offer them premium upgrades or personalized financial products.
* Clients with older expiration dates (pre-2016) could be targeted for re-engagement campaigns to encourage new card sign-ups.

**Chart 10**

**Analysis and Interpretation:**

The bar chart represents the count of client IDs based on different card brands (Amex, Discover, Mastercard, and Visa) and categorizes them into three card types: Credit, Debit, and Debit (Prepaid).

1. Mastercard has the highest number of users (3,209 total), followed by Visa (2,326), Amex (402), and Discover (209). This indicates Mastercard's dominance in card issuance.
2. Debit cards are the most commonly used card type for Mastercard (2,191) and Visa (1,320), highlighting a preference for spending directly from bank accounts.
3. Credit cards are more popular for Amex and Discover users, with Amex having 402 credit card users and Discover having 209, showing a preference for credit-based transactions over debit or prepaid options.
4. Prepaid debit cards are relatively low in usage, with Mastercard having 383 and Visa 195, indicating that prepaid cards are not as widely adopted compared to standard debit and credit cards.

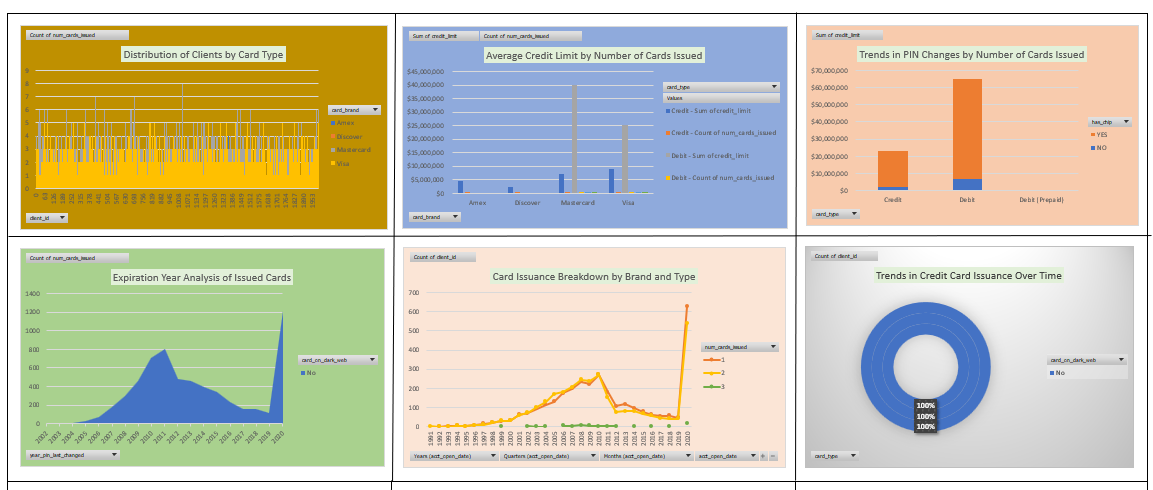
**Observations:**

* Mastercard and Visa dominate the market, with a significantly higher number of users than Amex and Discover.
* Credit cards are more popular for Amex and Discover users, suggesting that these brands may target a customer base that relies on credit rather than direct account withdrawals.
* Debit card usage is significantly higher for Mastercard and Visa, indicating that many customers prefer direct transactions without accumulating credit debt.
* Prepaid debit cards have the least adoption, suggesting that they may not be a preferred choice for most customers.

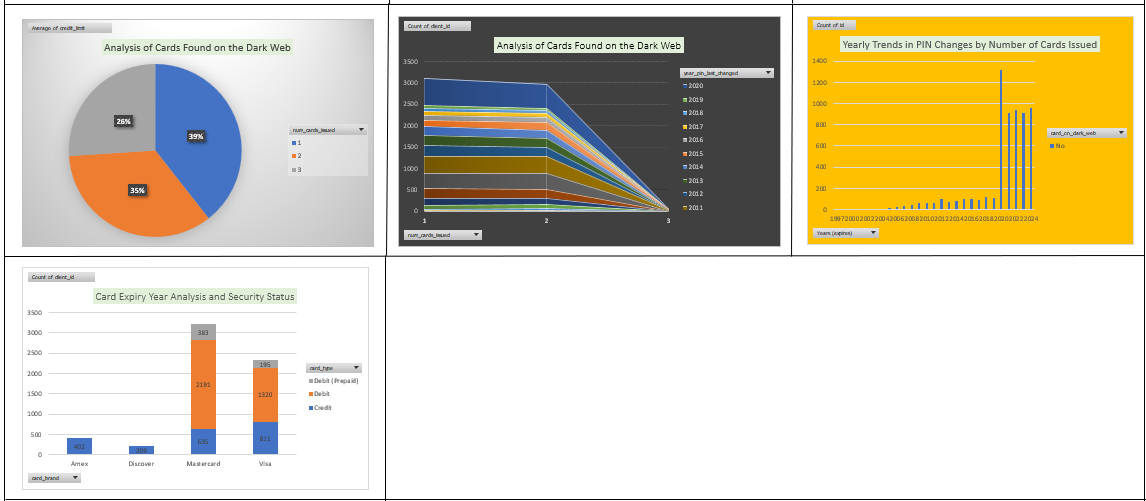
**Business Implications:**

* Banks and financial institutions should focus on Mastercard and Visa partnerships to reach a broader customer base.
* Given the strong preference for credit cards with Amex and Discover, these brands may benefit from offering competitive rewards or lower interest rates.
* There is an opportunity to promote prepaid debit cards, especially among users who may want controlled spending options.
* Debit card users might be encouraged to transition to credit cards with attractive offers like cashback or lower annual fees.

**DASH BOARD 1**

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**DASH BOARD 2**



**CONCLUSION**

The analysis of credit card transactions reveals significant trends in customer behaviour, card issuance, credit limits, fraud risks, and expiration patterns. The increasing adoption of credit cards, with most customers holding one or two cards, indicates a growing reliance on digital payments. However, the high number of soon-to-expire cards suggests the need for proactive renewal strategies to retain customers. Credit limits vary widely, influencing spending behaviour and financial risk, highlighting the importance of personalized credit offerings. Additionally, security concerns arise as some cards appear on the dark web, and many users do not frequently change their PINs, increasing vulnerability to fraud. Implementing stronger security measures, such as AI-driven fraud detection and PIN change policies, is crucial. The analysis also suggests that multiple credit card holders tend to have higher credit limits, necessitating better credit risk assessment to prevent overspending and defaults. As transaction volumes continue to rise, predictive analytics can help financial institutions optimize decision-making, improve fraud prevention, and enhance customer engagement. To stay competitive, banks must adopt data-driven strategies, improve security measures, and offer personalized financial products that cater to evolving customer needs.

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