Vendor Performance Analysis

Driving Data-Driven Purchasing and Inventory Decisions

Prepared by:
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Tools & Technologies:
SQL • Python (Pandas, Matplotlib) • Power BI • SQLite

Project Type:
End-to-End Data Analytics Project

1. Executive Summary :

This project presents an end-to-end analysis of vendor performance, purchasing behavior, and inventory efficiency within a retail business context. The objective of the analysis is to enable data-driven decision-making in areas such as vendor selection, pricing strategy, bulk purchasing, and inventory optimization. The study integrates SQL for data extraction and transformation, Python for exploratory analysis and statistical validation, and Power BI for interactive visualization and reporting.

Through comprehensive data cleaning and aggregation, vendor-level metrics were developed to evaluate sales contribution, purchase concentration, profitability, and inventory turnover. The analysis highlights a strong concentration of purchasing activity among a small group of vendors, exposing the business to potential supply chain and negotiation risks. At the same time, a substantial portion of working capital is locked in slow-moving and unsold inventory, negatively impacting cash flow and operational efficiency.

The study also evaluates the effectiveness of bulk purchasing strategies, revealing significant unit-cost savings when purchases are made in large volumes. However, the findings indicate that aggressive bulk buying, when not aligned with demand patterns, contributes to excess inventory and margin erosion. Furthermore, profitability analysis shows that high-volume vendors are not necessarily the most profitable, suggesting inefficiencies in pricing, cost structures, or vendor agreements.

To strengthen the analytical rigor, statistical hypothesis testing was performed to compare profit margins across different vendor segments. The results confirm a statistically significant difference in profitability, demonstrating that vendors operate

under distinct cost and pricing models. These insights emphasize the need for differentiated vendor management strategies rather than a one-size-fits-all approach.

Key Highlights : ----

- **Vendor Concentration:**
  The top 10 vendors account for approximately **76.31%** of total purchase value, indicating a high dependency on a limited supplier base.

- **Profitability Performance:**
  The business generated a total gross profit of $454.97K, with an average vendor profit margin of 53.82%, though margins vary significantly across vendors.

- **Bulk Purchasing Impact:**
  Bulk purchasing reduces unit costs by approximately 68–70%, delivering clear cost advantages when aligned with demand forecasts.

- **Statistical Validation:**
  Hypothesis testing confirms significant differences in profit margins between high-volume and low-volume vendors, reinforcing the need for targeted vendor strategies.

Overall, this analysis provides actionable insights to improve vendor diversification, optimize bulk purchasing decisions, reduce inventory holding costs, and enhance overall profitability. The findings are supported by interactive Power BI dashboards designed to assist stakeholders in ongoing monitoring and strategic planning.

2. Business Problem Statement :

Effective inventory and sales management are critical to optimizing profitability in the retail and wholesale industry. Organizations must continuously balance pricing strategies, vendor relationships, and inventory levels to avoid revenue leakage, excess holding costs, and operational inefficiencies. Poor pricing decisions, slow inventory turnover, and over-reliance on a limited number of vendors can significantly impact margins and cash flow.

Despite consistent purchasing activity, many businesses struggle to translate sales volume into sustainable profitability. High purchase concentration among a few vendors increases supply chain risk, while inefficient bulk purchasing and inaccurate demand estimation often lead to overstocking and slow-moving inventory. These challenges highlight the need for a structured, data-driven approach to vendor and inventory management.

The primary objectives of this analysis are to:

- Identify underperforming brands that require promotional support or pricing optimization to improve sales performance without sacrificing profitability.

- Determine top-contributing vendors based on sales volume, purchase value, and gross profit to understand vendor dependency and concentration risk.

- Analyze the financial impact of bulk purchasing, evaluating whether large-volume orders effectively reduce unit costs and improve margins.

- Assess inventory turnover patterns to detect inefficiencies, reduce holding costs, and release capital tied up in slow-moving stock.

- Investigate profitability variations between high-performing and low-performing vendors to identify structural differences in pricing, cost, and operational strategies.

By addressing these objectives, the analysis aims to support informed decision-making that enhances profitability, improves inventory efficiency, and reduces operational risk through optimized vendor management.

3. Data Sources & Data Pipeline :

This analysis is built on multiple transactional datasets that capture end-to-end vendor purchasing and sales activity within a retail business environment. The primary data sources include:

- **Sales Data**: Transaction-level records containing sales quantity, sales value, pricing, and applicable taxes.
- **Purchase Data**: Vendor purchase transactions including purchase quantity, purchase price, and total purchase value.
- Vendor Master Data: Vendor identifiers, vendor names, and brand associations.
- **Pricing and Inventory Data**: Product pricing, volume details, freight costs, and inventory-related attributes.

Data Ingestion and Transformation :

All raw datasets were ingested into a SQLite database to enable efficient data processing and transformation using SQL. Structured SQL queries with Common Table Expressions (CTEs) were designed to clean, join, and aggregate the raw data into analytical datasets.

Key transformations performed using SQL include:

- Aggregation of vendor-level purchase and sales metrics to enable comparative analysis across vendors.
- Calculation of total sales value, total purchase value, freight cost, excise tax, gross profit, and profit margin.
- Integration of sales, purchase, vendor, and pricing tables to create a unified analytical view.

- Generation of clean summary tables optimized for downstream analysis and reporting.

Analytical Pipeline:

The transformed summary tables were then imported into Python for further analysis. Python was used to:

- Perform exploratory data analysis (EDA)
- Detect and handle data quality issues, outliers, and inconsistencies
- Conduct correlation analysis and statistical hypothesis testing
- Derive additional analytical metrics such as inventory turnover and vendor contribution percentages

Finally, the processed data was connected to Power BI, where interactive dashboards were developed to visualize key performance indicators, vendor contribution patterns, inventory efficiency, and profitability trends. This end-to-end pipeline ensures data consistency while enabling scalable analysis and actionable business insights.

4. Data Cleaning & Preparation :

To ensure accuracy and meaningful insights, several data cleaning steps were applied:

Removed transactions with:

- Gross Profit ≤ 0 (loss-making transactions)
- Profit Margin ≤ 0
- Sales Quantity = 0 (unsold inventory)
- Handled missing values in freight cost and tax fields
- Converted numerical columns to appropriate data types
- Retained extreme but meaningful outliers for business interpretation

These steps ensured that the analysis focused on operationally relevant and financially meaningful record.

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5. Exploratory Data Analysis (EDA) :

Exploratory Data Analysis was conducted to understand the underlying structure of the data, identify data quality issues, detect anomalies, and uncover patterns that influence vendor performance, pricing behavior, and inventory efficiency. The EDA phase played a critical role in guiding subsequent analysis and ensuring that insights were grounded in reliable and meaningful data.

5.1 Negative and Zero Value Analysis :

The analysis revealed the presence of negative and zero-value records across several key financial metrics:

- **Negative Gross Profit:**
  Multiple products exhibited negative gross profit values, indicating scenarios where sales revenue was insufficient to cover procurement and associated costs. This points to potential issues such as inefficient pricing strategies, excessive discounting, high purchase prices, or elevated logistics and operational costs.

- **Negative Infinite Profit Margins (−∞):**
  Profit margin values reaching negative infinity were observed in cases where sales revenue was zero while costs were incurred. These records highlight extreme inefficiencies and were primarily associated with inventory that was purchased but never sold.

- **Zero Sales Quantity:**
  Products with zero sales quantity represent slow-moving or obsolete inventory, contributing to unnecessary inventory holding costs and blocked working capital. Identifying these products is critical for improving demand forecasting and inventory planning.

These findings emphasize the importance of filtering non-performing transactions to ensure that analytical conclusions are based on operationally meaningful data.

5.2 Outlier Detection :

Significant outliers were detected across multiple variables, indicating substantial variability in vendor operations and cost structures:

- **Purchase Price and Actual Price:**
  While average purchase and selling prices were relatively low, extreme maximum values were observed. This suggests the existence of premium or specialty products that operate under different pricing and margin dynamics compared to standard products.

- **Freight Cost:**
  Freight costs exhibited a wide range, from negligible amounts to extremely high values. Such variability indicates inconsistencies in logistics efficiency, shipment sizes, and freight agreements. High freight costs can materially impact gross profit and require closer monitoring.

- **Inventory Turnover:**
  Inventory turnover values ranged from zero to very high levels, reflecting uneven demand patterns across products and vendors. Extremely low turnover indicates excess inventory, while unusually high turnover may suggest strong demand or reliance on previously accumulated stock.

Outliers were not removed indiscriminately, as many represent legitimate business scenarios that provide valuable insights into vendor and product performance.

5.3 Correlation Insights :

Correlation analysis was conducted to understand the relationships between key purchasing, sales, and profitability variables:

- **Purchase Price vs. Profit Margin:**

  A weak correlation was observed, indicating that higher purchase prices do not necessarily result in lower profit margins. This suggests that factors such as pricing strategy, vendor agreements, and demand elasticity play a larger role in determining profitability.
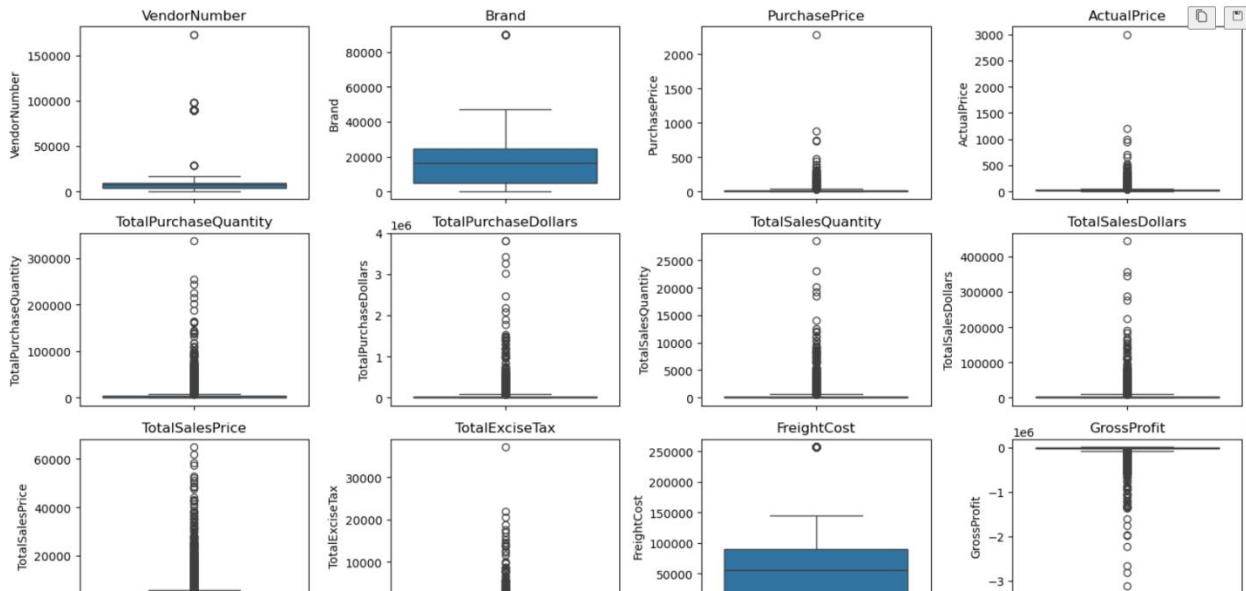
- **Purchase Quantity vs. Sales Quantity:**

  A strong positive correlation was identified, confirming that higher purchase volumes generally align with higher sales volumes. This indicates effective inventory replenishment for high-demand products.
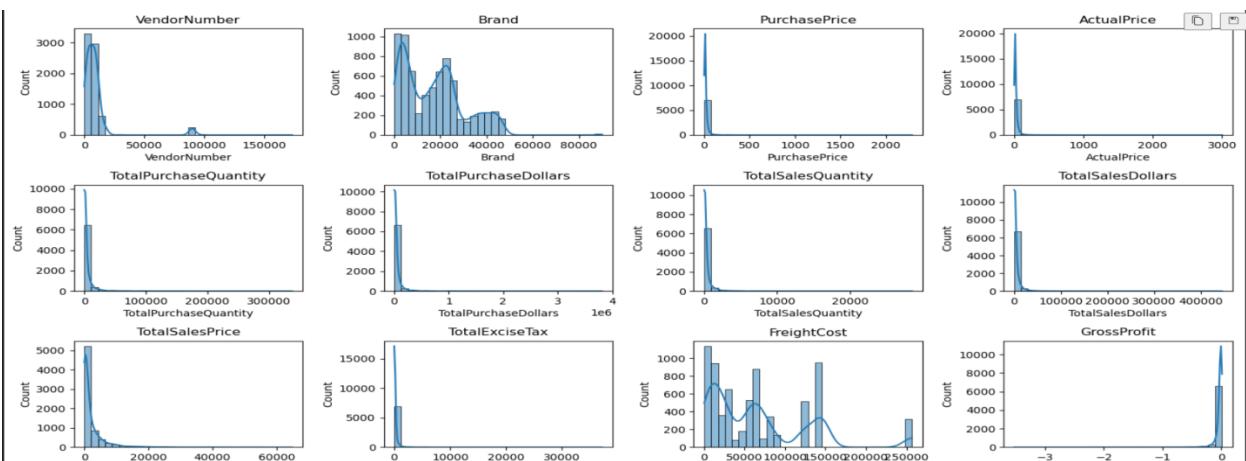
- **Sales Price vs. Profit Margin:**

  A negative relationship was observed, suggesting that increasing sales prices does not always improve margins. This may be due to competitive pricing pressures, discounts, or reduced sales volumes at higher price points.

These correlation insights helped shape deeper analyses into vendor performance, pricing efficiency, and inventory strategy.

|	count	mean	std	min	25%	50%	75%	max
VendorNumber	10692.0	10650.649458	18753.519148	2.000000e+00	3951.000000	7153.000000	9552.000000	2.013590e+05
Brand	10692.0	18039.228769	12662.187074	5.800000e+01	5793.500000	18761.500000	25514.250000	9.063100e+04
PurchasePrice	10692.0	24.385303	109.269375	3.600000e-01	6.840000	10.455000	19.482500	5.681810e+03
ActualPrice	10692.0	35.643671	148.246016	4.900000e-01	10.990000	15.990000	28.990000	7.499990e+03
TotalPurchaseQuantity	10692.0	3140.886831	11095.086769	1.000000e+00	36.000000	262.000000	1975.750000	3.376600e+05
TotalPurchaseDollars	10692.0	30106.693372	123067.799627	7.100000e-01	453.457500	3655.465000	20738.245000	3.811252e+06
TotalSalesQuantity	7144.0	342.562850	1047.307202	1.000000e+00	12.000000	61.000000	270.000000	2.854400e+04
TotalSalesDollars	7144.0	4624.092104	14662.388203	1.980000e+00	249.817500	1119.230000	4053.485000	4.448107e+05
TotalSalesPrice	7144.0	2257.384103	4593.699964	9.800000e-01	125.880000	635.445000	2422.330000	6.488997e+04
TotalExciseTax	7144.0	194.596923	1031.268200	2.000000e-02	1.910000	11.825000	68.642500	3.716376e+04
FreightCost	10692.0	61433.763214	60938.458032	9.000000e-02	14069.870000	50293.620000	79528.990000	2.570321e+05
GrossProfit	7144.0	-37733.259254	135072.752698	-3.528878e+06	-29873.030000	-6632.775000	-742.287500	1.286589e+04
ProfitMargin	7144.0	-2126.093498	63950.769470	-5.379400e+06	-1043.079362	-684.848837	-295.087299	9.923747e+01
StockTurnover	7144.0	0.443760	2.424274	1.264574e-05	0.056476	0.084410	0.166667	1.020000e+02
SalesToPurchaseRatio	7144.0	0.645805	3.376317	1.858909e-05	0.087483	0.127413	0.253109	1.311429e+02

6. Key Analytical Findings :

This section summarizes the most important analytical insights derived from vendor-level purchase, sales, profitability, and inventory metrics. Each finding is directly linked to business decision-making and operational risk management.

6.1 Vendor Contribution (Pareto Analysis) -

A Pareto (80/20) analysis was conducted to evaluate the concentration of purchases across vendors. The results indicate that the **top 10** vendors account for approximately **76.31%** of the total purchase value, while the remaining vendors collectively contribute less than one-quarter of total purchases.

This high level of concentration highlights a significant vendor dependency risk. Over-reliance on a small group of suppliers can expose the business to supply chain disruptions, pricing pressure, and reduced negotiation leverage. Any operational, logistical, or contractual issues affecting these vendors could have a disproportionate impact on business continuity and profitability.

From a strategic perspective, this finding underscores the need to diversify the vendor base and develop alternative sourcing strategies to mitigate risk.

6.2 Top Vendors by Sales Performance -

Sales analysis identified vendors such as Ultra Beverage Company LLP, Martignetti Companies, and M S Walker Inc as the leading contributors to total sales revenue. These vendors play a critical role in driving overall sales volume.

However, further analysis reveals that high sales volume does not consistently translate into higher profit margins. Several top-selling vendors operate at relatively lower margins compared to vendors with lower sales volumes. This suggests potential inefficiencies related to pricing strategies, cost structures, discounting practices, or vendor agreements.

This insight indicates that sales performance alone is insufficient as a success metric, and profitability must be evaluated alongside volume when assessing vendor effectiveness.

6.3 Impact of Bulk Purchasing on Cost Efficiency :

The analysis demonstrates that bulk purchasing significantly reduces per-unit costs, with large-volume orders achieving approximately **68–70%** lower unit prices compared to smaller purchases. This confirms the financial advantage of volume-based procurement strategies.

However, the data also reveals a critical trade-off. When bulk purchasing is not aligned with actual demand, it contributes to inventory accumulation and slow-moving stock, increasing holding costs and tying up working capital. While bulk purchasing improves unit economics, its effectiveness depends on accurate demand forecasting and disciplined inventory planning.

This finding highlights the importance of balancing cost savings with inventory turnover to avoid margin erosion.

6.4 Profitability Comparison & Statistical Hypothesis Testing :

To assess whether vendor profitability differs meaningfully across vendor groups, vendors were segmented into high-volume and low-volume categories based on purchase and sales contribution.

- High-volume vendors:
  Average profit margin ≈ **57.08%**
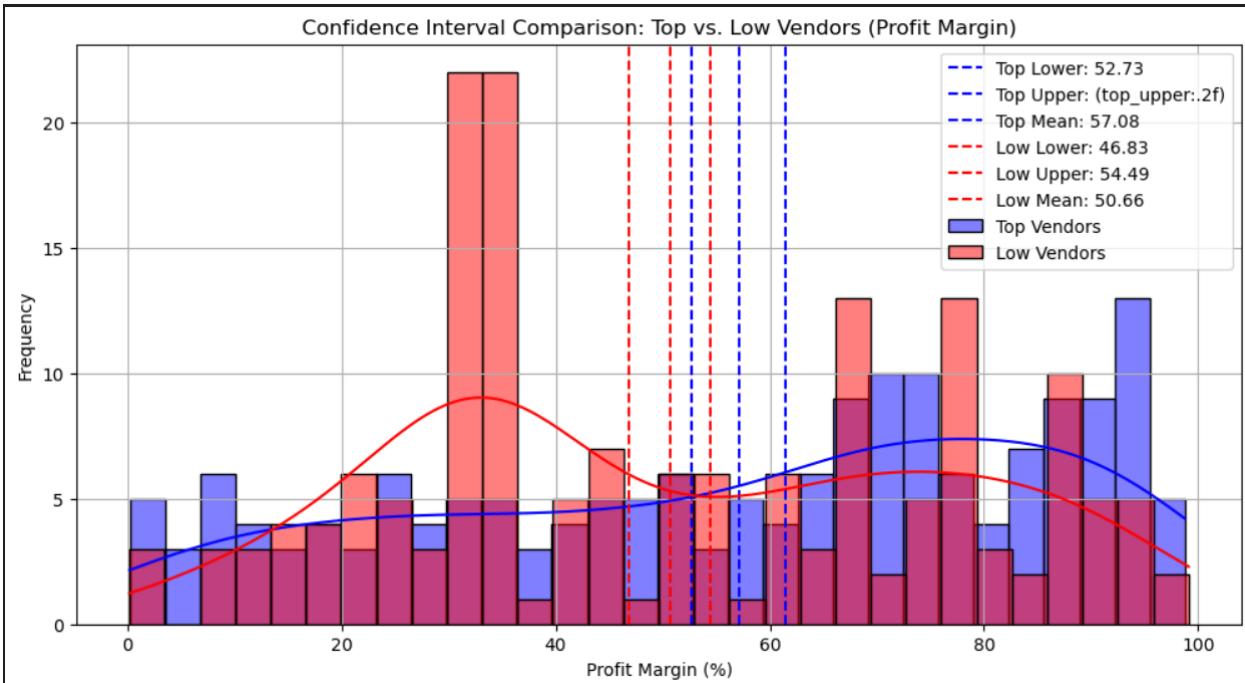
- Low-volume vendors:
  Average profit margin ≈ **50.66%**

Statistical hypothesis testing was performed to validate whether this difference in profit margins is significant. The results confirm that the observed difference is statistically significant, indicating that the two vendor groups operate under distinct pricing, cost, or operational models.

This finding suggests that:

- High-volume vendors prioritize scale and volume, at the profit margins.
- Low-volume vendors maintain lower margins and also struggle with sales penetration or demand.

As a result, vendor management strategies should be segmented and customized, rather than applying uniform pricing or purchasing policies across all vendors

Confidence Interval Comparison: Top vs. Low Vendors (Profit Margin)

Legend:
- Top Lower: 52.73
- Top Upper: (top_upper:.2f)
- Top Mean: 57.08
- Low Lower: 46.83
- Low Upper: 54.49
- Low Mean: 50.66
- Top Vendors
- Low Vendors

Conclusion from above graph------

1.The confidence interval for low-performing vendors (46.83% to 54.49%) is significantly lower than that of top-performing vendors (52.73% to 61.42%).

2.This suggests that vendors with higher sales tend to maintain higher profit margins, potentially due to premium pricing or lower operational costs.

3.For low-Performing Vendors: If they aim to improve profitability, they could explore selective price adjustments, cost optimization, or bundling strategies

7. Power BI Dashboard Overview :

An interactive **Power BI dashboard** was developed to translate analytical findings into a decision-support tool for business stakeholders. The dashboard provides a consolidated view of vendor performance, purchasing concentration, profitability, and inventory efficiency, enabling both high-level monitoring and detailed exploration.

Dashboard Components and Insights

- **Key Performance Indicator (KPI) Cards:**
  The dashboard includes KPI cards displaying **total sales, total purchases, gross profit, average profit margin, and total excise tax**. These metrics provide an immediate snapshot of overall business performance and allow stakeholders to quickly assess financial health.

- **Vendor Contribution (Pareto) Analysis:**
  A Pareto-style **donut chart** highlights the concentration of purchases among vendors by visualizing the contribution of the top vendors compared to all others. This visual clearly communicates vendor dependency risk and helps identify opportunities for supplier diversification.

- **Brand Performance Scatter Plots:**
  Scatter plots are used to identify **low-performing brands** by comparing sales volume and profitability. Brands with low sales and low margins are easily distinguishable, enabling targeted pricing, promotional, or discontinuation decisions.

- **Vendor and Brand Ranking Charts:**
  Bar charts rank vendors and brands based on sales performance, allowing

stakeholders to quickly identify top contributors and compare relative performance across suppliers.

- **Inventory Turnover and Profitability Indicators:**
  Visual cues and comparative charts highlight vendors with **low inventory turnover and weak profit margins**, helping prioritize corrective actions such as demand-driven purchasing, inventory clearance, or renegotiation of vendor terms.
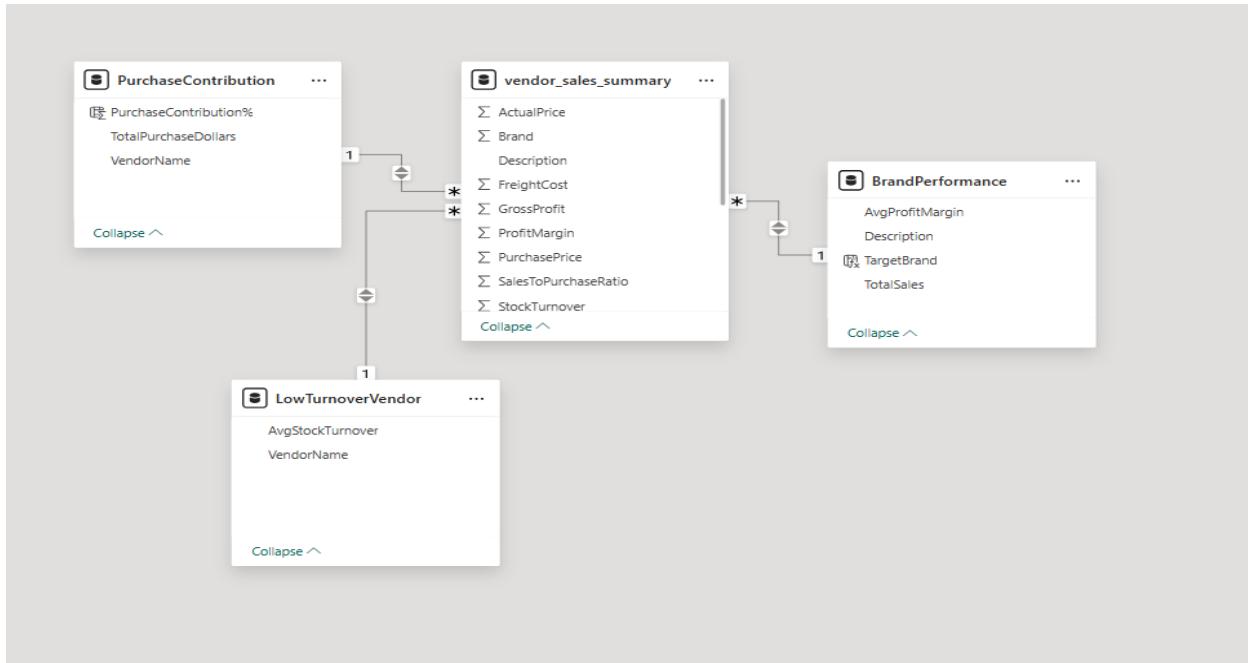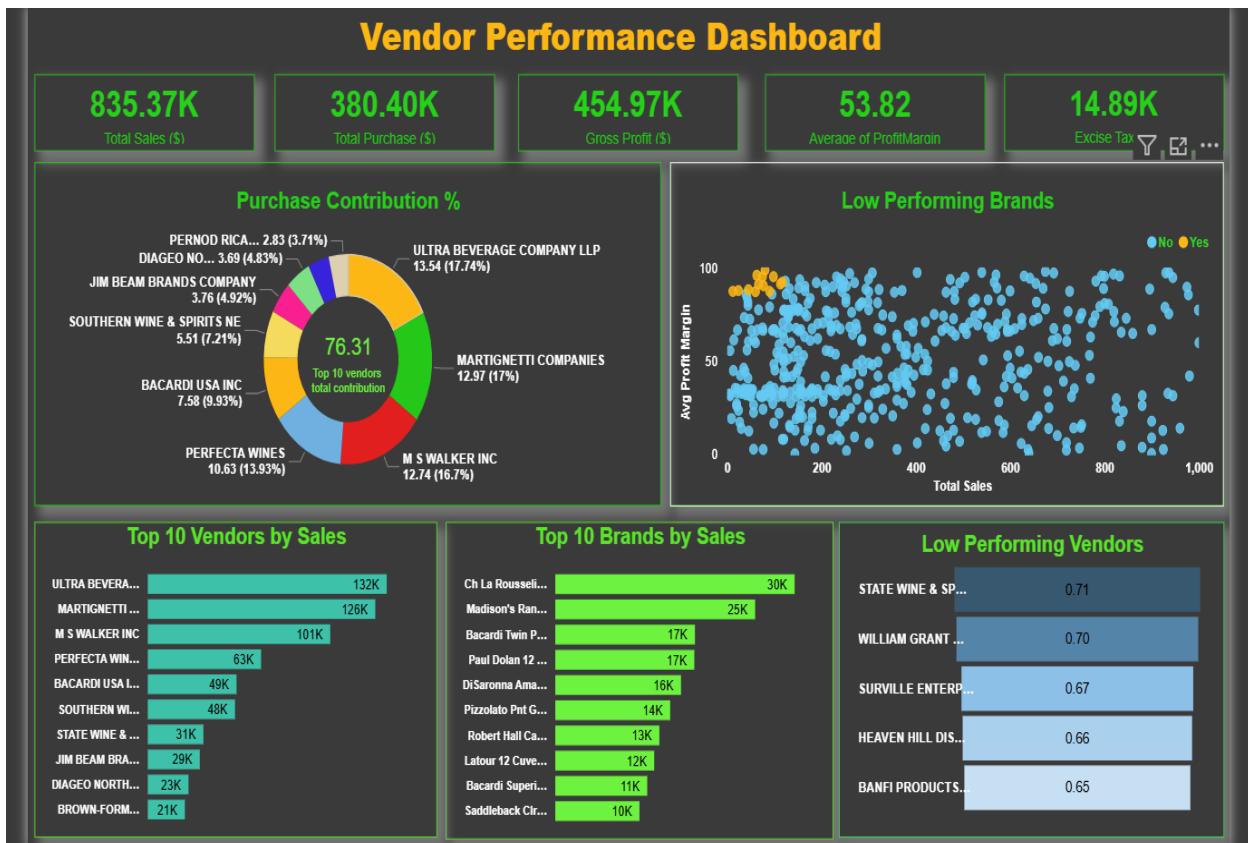
Business Value

The dashboard is designed for **executive-level decision-making**, enabling stakeholders to:

- Monitor key performance metrics in real time
- Quickly identify high-risk vendors and underperforming brands
- Evaluate the impact of purchasing and pricing strategies
- Support data-driven discussions around vendor management and inventory optimization

By combining clarity, interactivity, and business relevance, the Power BI dashboard serves as a practical tool for ongoing performance monitoring and strategic planning.

Vendor Performance Dashboard

835.37K	380.40K	454.97K	53.82	14.89K
Total Sales ($)	Total Purchase ($)	Gross Profit ($)	Average of ProfitMargin	Excise Tax

Purchase Contribution %

PERNOD RICA... 2.83 (3.71%)
DIAGEO NO... 3.69 (4.83%)
JIM BEAM BRANDS COMPANY 3.76 (4.92%)
SOUTHERN WINE & SPIRITS NE 5.51 (7.21%)
BACARDI USA INC 7.58 (9.93%)
PERFECTA WINES 10.63 (13.93%)
M S WALKER INC 12.74 (16.7%)
MARTIGNETTI COMPANIES 12.97 (17%)
ULTRA BEVERAGE COMPANY LLP 13.54 (17.74%)

76.31 Top 10 vendors total contribution

Low Performing Brands

Top 10 Vendors by Sales

Vendor	Sales
ULTRA BEVERA...	132K
MARTIGNETTI ...	126K
M S WALKER INC	101K
PERFECTA WIN...	63K
BACARDI USA I...	49K
SOUTHERN WI...	48K
STATE WINE & ...	31K
JIM BEAM BRA...	29K
DIAGEO NORTH...	23K
BROWN-FORM...	21K

Top 10 Brands by Sales

Brand	Sales
Ch La Rousseli...	30K
Madison's Ran...	25K
Bacardi Twin P...	17K
Paul Dolan 12 ...	17K
DiSaronna Ama...	16K
Pizzolato Pnt G...	14K
Robert Hall Ca...	13K
Latour 12 Cuve...	12K
Bacardi Superi...	11K
Saddleback Clr...	10K

Low Performing Vendors

Vendor	Value
STATE WINE & SP...	0.71
WILLIAM GRANT ...	0.70
SURVILLE ENTERP...	0.67
HEAVEN HILL DIS...	0.66
BANFI PRODUCTS...	0.65

PurchaseContribution
- PurchaseContribution%
- TotalPurchaseDollars
- VendorName

vendor_sales_summary
- Σ ActualPrice
- Σ Brand
- Description
- Σ FreightCost
- Σ GrossProfit
- Σ ProfitMargin
- Σ PurchasePrice
- Σ SalesToPurchaseRatio
- Σ StockTurnover

BrandPerformance
- AvgProfitMargin
- Description
- TargetBrand
- TotalSales

LowTurnoverVendor
- AvgStockTurnover
- VendorName

8. Business Recommendations :

Based on the insights derived from vendor performance, purchasing behavior, profitability, and inventory analysis, the following strategic recommendations are proposed to improve operational efficiency, reduce risk, and enhance overall profitability.

8.1 Diversify the Vendor Base

The analysis shows that a significant portion of total purchases is concentrated among a small group of vendors, creating a high level of dependency. To mitigate supply chain risk and strengthen negotiation leverage, the organization should gradually diversify its vendor portfolio by onboarding alternative suppliers and redistributing purchase volumes where feasible.

Diversification will reduce exposure to disruptions, improve pricing flexibility, and enhance long-term supply chain resilience.

8.2 Optimize Bulk Purchasing Strategy

Bulk purchasing has been shown to deliver substantial unit-cost savings of approximately 68–70%. However, excessive bulk buying without accurate demand planning contributes to inventory accumulation and increased holding costs.

It is recommended that bulk purchasing be applied selectively, guided by historical demand patterns, inventory turnover rates, and sales forecasts. Aligning bulk orders with demand will preserve cost advantages while minimizing excess inventory risk.

8.3 Reprice and Promote Low-Sales, High-Margin Brands

Several brands exhibit strong profit margins but low sales volumes, indicating untapped revenue potential. Strategic pricing adjustments, targeted promotions, or improved product visibility can help increase sales volumes without significantly compromising margins.

These actions can improve overall revenue contribution while maintaining profitability.

8.4 Clear Slow-Moving and Obsolete Inventory

A substantial amount of capital is tied up in slow-moving and unsold inventory. To release working capital and reduce storage costs, targeted clearance strategies should be implemented. These may include limited-time discounts, bundled offers, or channel-specific promotions.

Clearing obsolete inventory will improve cash flow and allow reinvestment in higher-performing products and vendors.

8.5 Improve Logistics and Freight Cost Management

Freight costs display high variability across vendors and shipments, directly impacting gross profit. Reviewing freight contracts, optimizing shipment sizes, and consolidating deliveries where possible can help reduce logistics cost volatility.

Improved logistics planning will contribute to more predictable cost structures and stronger profit margins.

9. Limitations & Future Scope :

While this analysis provides valuable insights into vendor performance, purchasing efficiency, and inventory management, certain limitations should be acknowledged. Recognizing these limitations helps contextualize the findings and highlights opportunities for future enhancement.

9.1 Limitations :

- **Lack of Seasonal and Time-Series Analysis:**
  The analysis does not incorporate seasonal demand patterns or time-series forecasting. As a result, variations driven by seasonality, promotional cycles, or long-term demand trends could not be evaluated.

- **Absence of Marketing and Promotional Spend Data:**
  Information related to marketing campaigns, promotional discounts, and advertising spend was not available. This limits the ability to fully assess the impact of marketing efforts on sales performance and profitability.

- **Static Demand Assumptions:**
  Purchasing and sales analyses were based on historical data without dynamic demand modeling, which may not fully capture changes in consumer behavior or market conditions.

9.2 Future Scope and Enhancements :

To extend the analytical depth and business value of this project, the following enhancements are recommended :

- **ABC Inventory Classification:**
  Categorizing inventory into A, B, and C classes based on value and turnover can help prioritize inventory management efforts and optimize stock levels.

- **Vendor Performance Scorecards:**
  Developing comprehensive vendor scorecards incorporating metrics such as profitability, delivery reliability, inventory turnover, and cost efficiency would enable more structured vendor evaluations.

- **Predictive Demand Forecasting:**
  Applying time-series or machine learning models to forecast demand can improve purchasing decisions, reduce overstocking, and enhance inventory turnover.

- **Margin Optimization Models:**
  Advanced pricing and margin optimization techniques can be used to balance sales volume and profitability across products and vendors.

10. Conclusion :

This project demonstrates a comprehensive, end-to-end approach to data analytics by transforming raw transactional data into actionable business insights. Through the integration of SQL-based data preparation, Python-driven exploratory and statistical analysis, and interactive Power BI visualizations, the study provides a clear understanding of vendor performance, purchasing efficiency, and inventory dynamics.

The analysis reveals critical insights, including high vendor dependency risk, significant capital tied up in slow-moving inventory, and notable differences in profitability across vendor segments. While bulk purchasing delivers substantial cost benefits, the findings highlight the importance of aligning procurement strategies with demand patterns to avoid inventory inefficiencies and margin erosion.

By combining quantitative analysis with business-oriented interpretation, this project showcases the ability to not only analyze data but also translate insights into practical recommendations that support strategic decision-making. The interactive Power BI dashboard further enhances the usability of these insights by enabling stakeholders to monitor performance and identify risks in real time.

Overall, this project reflects the core competencies expected of a Data Analyst—data extraction and cleaning, analytical reasoning, statistical validation, and effective communication of insights. The methodologies and recommendations presented can serve as a foundation for improved vendor management, optimized inventory planning, and sustained profitability in a retail business environment.