VENDOR PERFORMANCE DATA ANALYTICS PROJECT REPORT

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BUSINESS PROBLEM

Effective inventory and sales management are critical for optimizing profitability in the retail and wholesale industry. Companies need to ensure that they are not incurring losses due to inefficient pricing, poor inventory turnover, or vendor dependency. The goal of this analysis is to:

- Identify underperforming brands that require promotional or pricing adjustments.
- Determine top vendors contributing to sales and gross profit.
- Analyze the impact of bulk purchasing on unit costs.
- Assess inventory turnover to reduce holding costs and improve efficiency.
- Investigate the profitability variance between high-performing and low-performing vendors.

DATASET DESCRIPTION

This section includes a detailed description of data from the number of instances to the missing values, outliers, types of data attributes, and many more. This description helps us to understand our data.

The raw dataset consists of 6 relational tables extracted from an e-commerce inventory management system:

- **begin_inventory**: Tracks starting stock for each product.

  - Columns: InventroyId, Store, City, Brand, Description, Size, onHand, Price, startDate

  - Count of Records : 205629

- **end_inventory**: Captures closing stock levels.

  - Columns: InventoryId, Store, City, Brand, Description, Size, onHand, Price, endDate

  - Count of Records : 224489

- **purchase_Prices**: Contains unit-level purchase prices for products

  - Columns: Brand, Description, Price, Size, Volume, Classification PurchasePrice, VendorNumber, VendorName

  - Count of Records : 12261

- **purchases**: Purchase order details.

  - Columns: InventoryId Store, Brand, Description, Size, VendorNumber VendorName, PONumber, PODate, ReceivingDate, InvoiceDate PayDate, PurchasePrice, Quantity, Dollars, Classification

  - Count of Records : 2372474

- **sales**: Tracks units sold and revenue.

  - Columns: InventoryId Store, Brand, Description, Size, SalesQuantity SalesDollars, SalesPrice, SalesDate, Volume, Classification, ExciseTax, VendorNo, VendorName

  - Count of Record : 12825363

- **vendor_invoice**: Contains vendor info.

  - Columns: VendorNumber, VendorName, InvoiceDate, PONumber, PODate PayDate, Quantity, Dollars, Freight, Approval

  - Count of Records : 4453

These were ingested into a SQLite database inventory.db using Python's sqlite3 and pandas libraries.

DATA PREPROCESSING

Using SQL queries within the inventory.db database, the raw tables were joined and aggregated to form a unified table "Vendor_sales_performance".

```
vendor_sales_summary = pd.read_sql_query("""WITH FreightSummary AS(
SELECT
VendorNumber,
SUM(Freight) AS FreightCost
FROM vendor_invoice
GROUP BY VendorNumber
),

PurchaseSummary AS(
Select
p.VendorNumber,
p.VendorName,
p.Brand,
p.PurchasePrice,
p.Description,
pp.Price AS ActualPrice,
pp.Volume,
SUM(p.Quantity) AS TotalPurchaseQuantity,
SUM(p.Dollars) AS TotalPurchaseDollars
FROM purchases p
JOIN purchase_prices pp
ON p.Brand = pp.Brand
WHERE p.PurchasePrice>0
GROUP BY p.VendorNumber, p.VendorName, p.Brand, p.Description, p.PurchasePrice, pp.Price,
pp.volume),

SalesSummary AS(
SELECT
VendorNo,
Brand,
SUM(SalesQuantity) AS TotalSalesQuantity,
SUM(SalesDollars) AS TotalSalesDollars,
SUM(SalesPrice) AS TotalSalesPrice,
SUM(ExciseTax) AS TotalExciseTax
FROM Sales
GROUP BY VendorNo, Brand)

SELECT
ps.VendorNumber,
ps.VendorName,
ps.Brand,
ps.Description,
ps.PurchasePrice,
ps.ActualPrice,
ps.Volume,
```

```
ps.TotalPurchaseQuantity,
ps.TotalPurchaseDollars,
ss.TotalSalesQuantity,
ss.TotalSalesDollars,
ss.TotalSalesPrice,
ss.TotalExciseTax,
fs.FreightCost
FROM PurchaseSummary ps
LEFT JOIN SalesSummary ss
ON ps.VendorNumber = ss.VendorNo
AND ps.Brand = ss.Brand
LEFT JOIN FreightSummary fs
ON ps.VendorNumber = fs.VendorNumber
ORDER BY ps.TotalPurchaseDollars DESC""",conn)
```

Handling Null Values

Checking the number of null values for each column:

```
VendorNumber            0
VendorName              0
Brand                   0
Description             0
PurchasePrice           0
ActualPrice             0
Volume                  0
TotalPurchaseQuantity   0
TotalPurchaseDollars    0
TotalSalesQuantity    178
TotalSalesDollars     178
TotalSalesPrice       178
TotalExciseTax        178
FreightCost             0
dtype: int64
```

Total salesquantity, SalesDollars, SalesPrice, Excisetax have null values maybe b/c some vendor puchased items but didn't sold them

Filling 0 on these NULL values

```
vendor_sales_summary.fillna(0,inplace = True)
vendor_sales_summary.isnull().sum()

VendorNumber            0
VendorName              0
Brand                   0
Description             0
PurchasePrice           0
ActualPrice             0
Volume                  0
TotalPurchaseQuantity   0
TotalPurchaseDollars    0
TotalSalesQuantity      0
TotalSalesDollars       0
TotalSalesPrice         0
TotalExciseTax          0
FreightCost             0
dtype: int64
```

Removing Inconsistencies

extra spaces after the vendor name can be observed which is removed

```
vendor_sales_summary['VendorName'] = vendor_sales_summary['VendorName'].str.strip()
vendor_sales_summary['VendorName'].unique()
```

Feature Extraction

```
vendor_sales_summary['GrossProfit'] = vendor_sales_summary['TotalSalesDollars']-vendor_sales_summary['TotalPurchaseDollars']

vendor_sales_summary['ProfitMargin'] = (vendor_sales_summary['GrossProfit'] / vendor_sales_summary['TotalSalesDollars'])*100

vendor_sales_summary['StoctTurnover'] = vendor_sales_summary['TotalSalesQuantity']/vendor_sales_summary['TotalPurchaseQuantity']

vendor_sales_summary['SalesToPurchaseRatio'] = vendor_sales_summary['TotalSalesDollars']/vendor_sales_summary['TotalPurchaseDollars']

vendor_sales_summary.columns
```

Data Filtering

To enhance the reliability of the insights, we removed inconsistent data points where:

- Gross profit <= 0 (to exclude transactions leading to losses).
- Profit Margin <= 0 (to ensure analysis focuses on profitable transactions).
- Total Sales Quantity = 0 (to eliminated inventory that were never sold).

EXPLORATRY DATA ANALYSIS INSIGHTS

Summary Statistics:

|	count	mean	std	min	25%	50%	75%	max
VendorNumber	10692.0	1.065065e+04	18753.519148	2.00	3951.000000	7153.000000	9552.000000	2.013590e+05
Brand	10692.0	1.803923e+04	12662.187074	58.00	5793.500000	18761.500000	25514.250000	9.063100e+04
PurchasePrice	10692.0	2.438530e+01	109.269375	0.36	6.840000	10.455000	19.482500	5.681810e+03
ActualPrice	10692.0	3.564367e+01	148.246016	0.49	10.990000	15.990000	28.990000	7.499990e+03
Volume	10692.0	8.473605e+02	664.309212	50.00	750.000000	750.000000	750.000000	2.000000e+04
TotalPurchaseQuantity	10692.0	3.140887e+03	11095.086769	1.00	36.000000	262.000000	1975.750000	3.376600e+05
TotalPurchaseDollars	10692.0	3.010669e+04	123067.799627	0.71	453.457500	3655.465000	20738.245000	3.811252e+06
TotalSalesQuantity	10692.0	3.077482e+03	10952.851391	0.00	33.000000	261.000000	1929.250000	3.349390e+05
TotalSalesDollars	10692.0	4.223907e+04	167655.265984	0.00	729.220000	5298.045000	28396.915000	5.101920e+06
TotalSalesPrice	10692.0	1.879378e+04	44952.773386	0.00	289.710000	2857.800000	16059.562500	6.728193e+05
TotalExciseTax	10692.0	1.774226e+03	10975.582240	0.00	4.800000	46.570000	418.650000	3.682428e+05
FreightCost	10692.0	6.143376e+04	60938.458032	0.09	14069.870000	50293.620000	79528.990000	2.570321e+05
GrossProfit	10692.0	1.213238e+04	46224.337964	-52002.78	52.920000	1399.640000	8660.200000	1.290668e+06
ProfitMargin	10692.0	-inf	NaN	-inf	13.324515	30.405457	39.956135	9.971666e+01
StockTurnover	10692.0	1.706793e+00	6.020460	0.00	0.807229	0.981529	1.039342	2.745000e+02
SalesToPurchaseRatio	10692.0	2.504390e+00	8.459067	0.00	1.153729	1.436894	1.665449	3.529286e+02
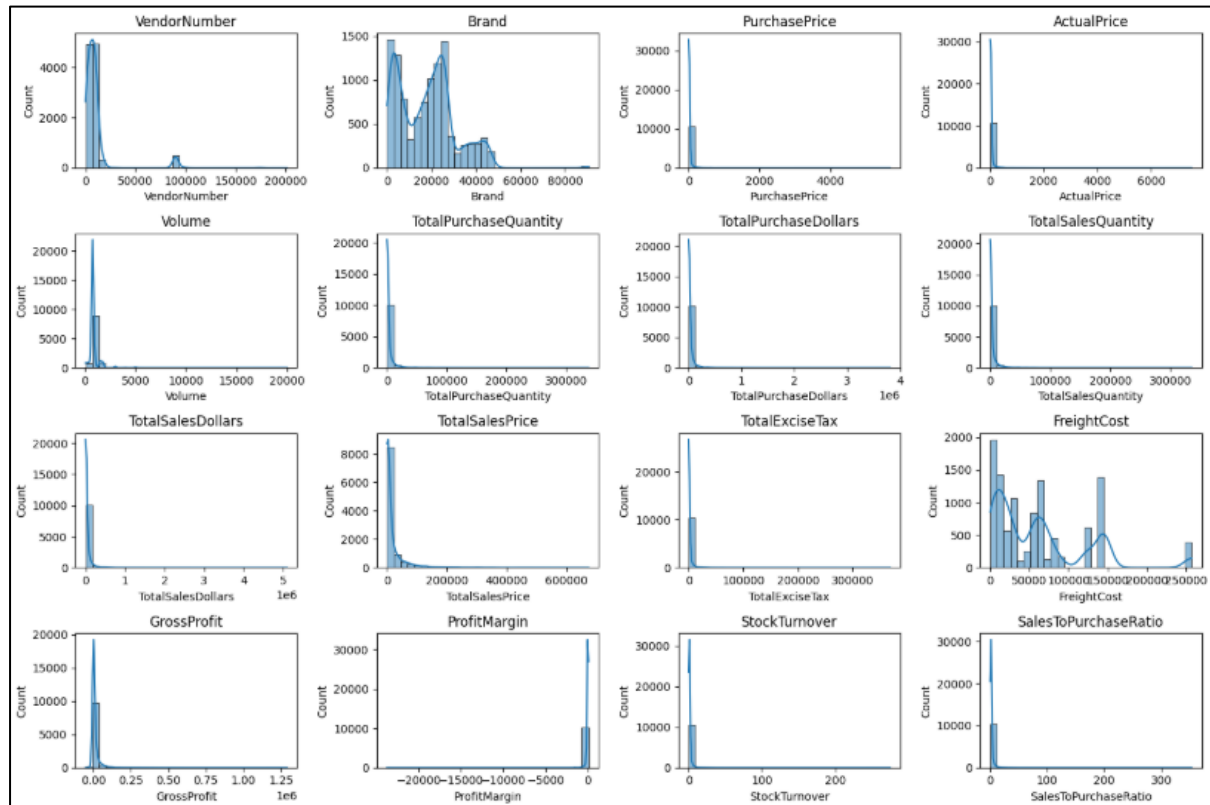
Figure - Distribution plans for Numerical Columns

Negative and Zero Values:

- **Gross Profit :** Minimum of -52,002.78 indicating potential losses due to high costs or heavy discounts. This could be due to selling products at lower prices than their purchase costs.
- **Profit Margin :** Has a minimum of $-\infty$, which suggests instances where revenue is zero or even lower than the total cost, leading to extreme negative profit margin.
- **Total Sales Quantity and Sales Dollars :** Some products show zero sales, indicating they were purchased but never sold. These may be slow-moving or obsolete stock, leading to inventory inefficiencies.
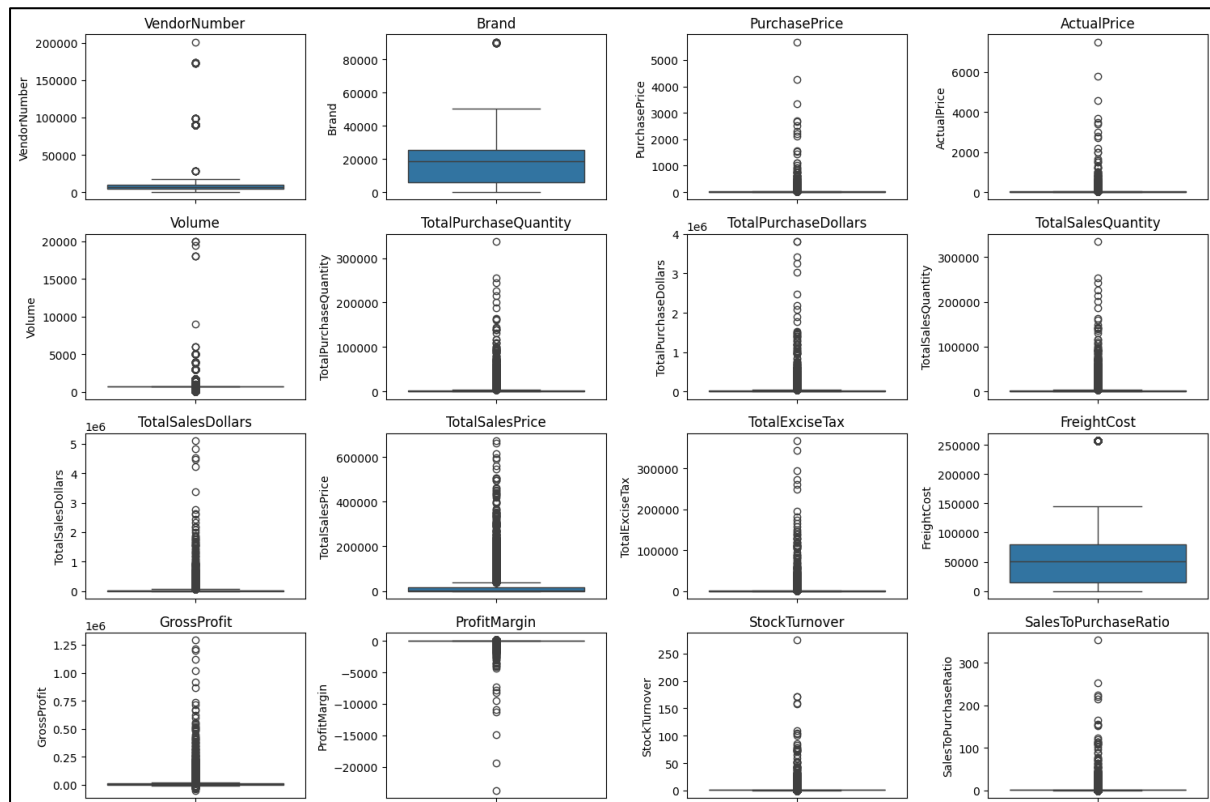
Outliers Detected by High Standard Deviations:

Figure : outlier detection with boxplots

Purchase and Actual Prices: The maximum values (5,681.81 and 7,499.99) are significantly higher than the mean (24.39 and 35.69), indicating premium product offerings.

Freight Cost: Extreme variation from 0.09 to 257,032.07 suggests logistics inefficiencies, bulk shipments, or erratic shipping costs across different produtcs.

Stock Turnover : Ranges form 0 to 274.5, suggesting some products sell rapidly while other remain unsold for long periods. A value greater than 1 indicated that sales for a product exceed the purchased quantity due to older stock fulfilling orders.
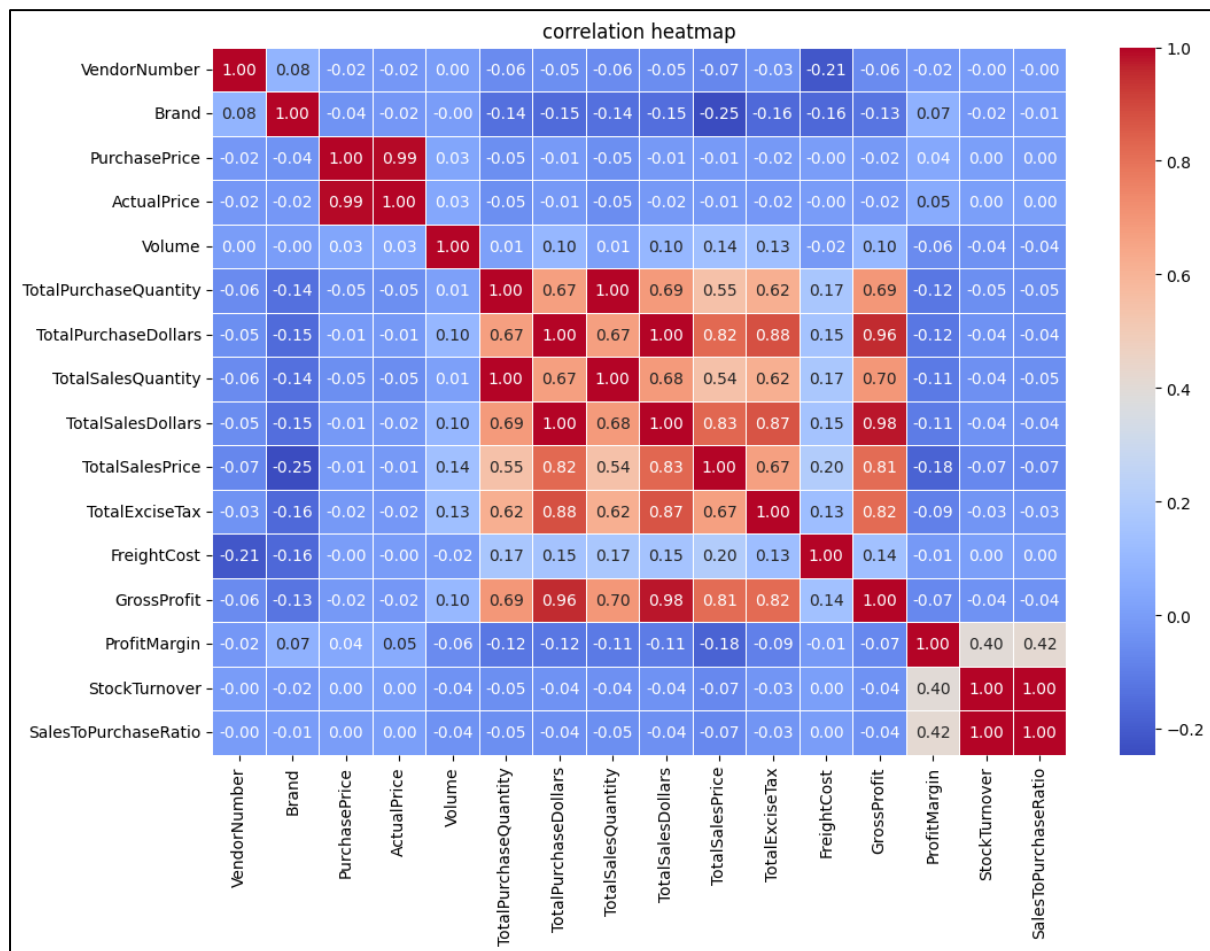
Correlation Insights

Figure: Correlation HeatMap

Purchase Price vs. Total Sales Dollars and Gross Profit : Weak Correlation (-0.012 and -0.016), indicating that price variations do not significantly impact sales revenue or profit.

Total Purchase Quantity vs. Total Sales Quantity: Strong correlation(0.999), confirming efficient inventory turnover.

Profit Margin vs. Total sales Price : Negative correlation (-0.179), suggesting increasing sales prices may lead to reduced margins, possibly due to competitive pricing pressures.

Stock Turnover vs. Gross Profit and Profit Margin : Weak negative correlation (-0.038 and -0.055), indicating that faster stock turnover does not necessarily equate to higher profitability.

RESEARCH QUESTIONS AND KEY FINDINGS

1. **Brands for Promotional or Pricing Adjustments**

	Brands with Low Sales but High Profit Margins:		
	Description	**TotalSalesDollars**	**ProfitMargin**
6199	Santa Rita Organic Svgn Bl	9.99	66.466466
2369	Debauchery Pnt Nr	11.58	65.975820
2070	Concannon Glen Ellen Wh Zin	15.95	83.448276
2188	Crown Royal Apple	27.86	89.806174
6237	Sauza Sprklg Wild Berry Marg	27.96	82.153076
...	...	...	...
5074	Nanbu Bijin Southern Beauty	535.68	76.747312
2271	Dad's Hat Rye Whiskey	538.89	81.851584
57	A Bichot Clos Marechaudes	539.94	67.740860
6245	Sbragia Home Ranch Merlot	549.75	66.444748
3326	Goulee Cos d'Estournel 10	558.87	69.434752

198 rows × 3 columns

198 brands exhibit lower sales but higher profit margins, which could benefit form targeted marketing, promotions, or price optimization to increase volume without compromising profitability.


Brands for Promotioal or Pricing Adjustments
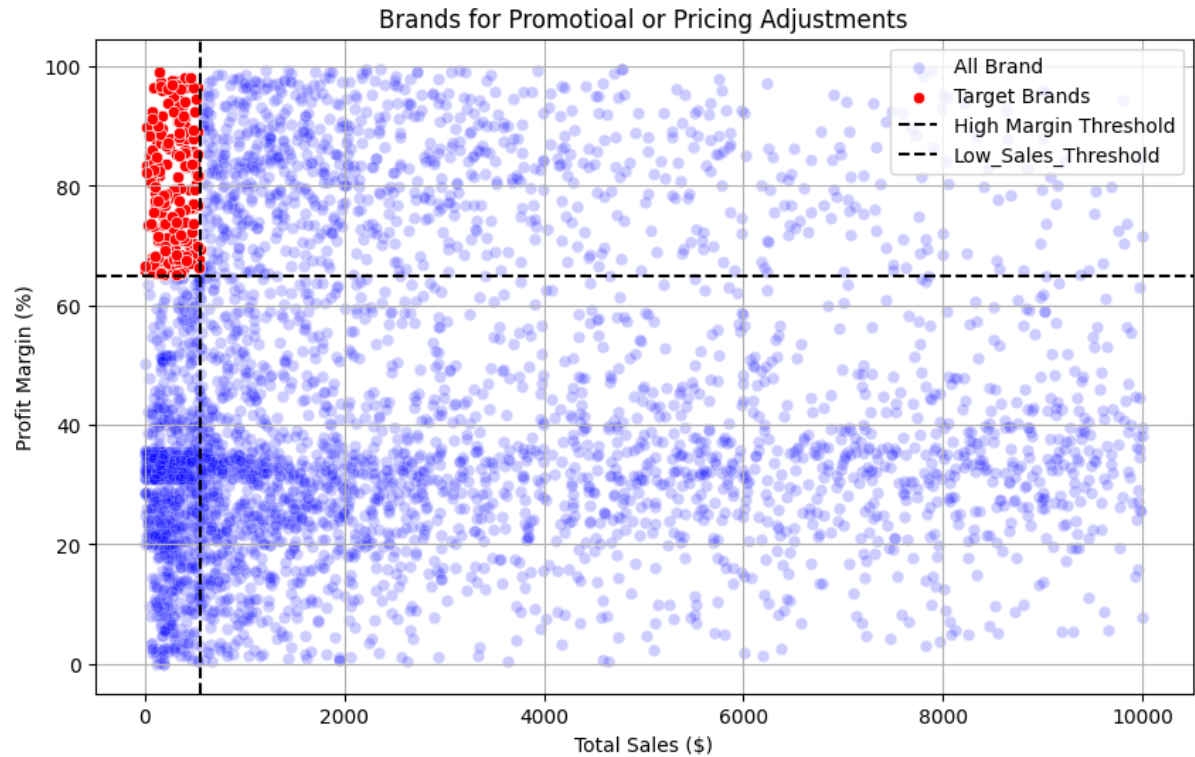
2. vendors and brands with the heighest sales performance
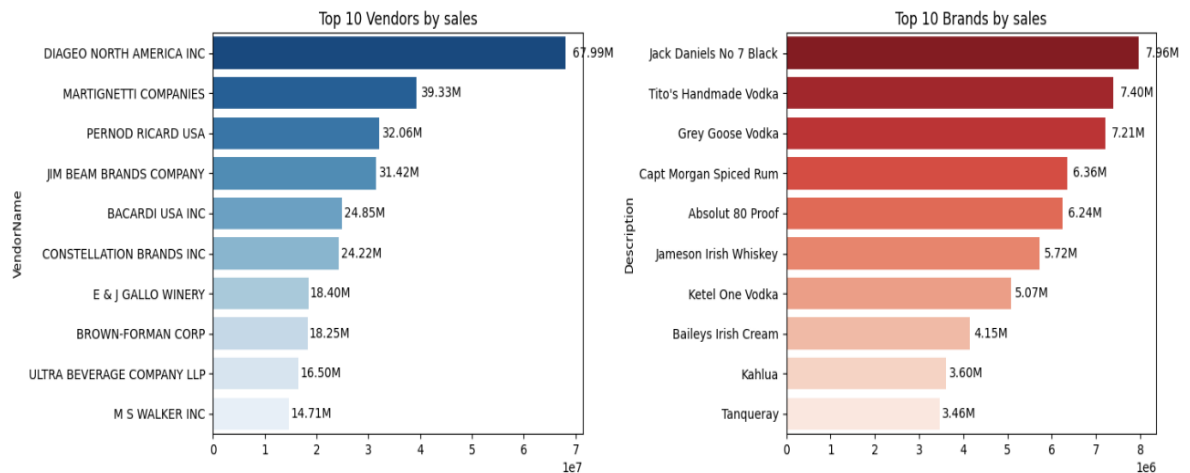
3. Top Vendors by Purchase Contribution

The top 10 vendors contribute 65.69% of total purchases, while the remaining vendors contribute only 34.31%. This over-reliance on a few vendors may introduce risks such as supply chain disruptions, indicating a need for diversification.

	VendorName	TotalPurchaseDollars	GrossProfit	TotalSalesDollars	PurchaseContribution %
25	DIAGEO NORTH AMERICA INC	50.10M	17.89M	67.99M	16.30
57	MARTIGNETTI COMPANIES	25.50M	13.83M	39.33M	8.30
68	PERNOD RICARD USA	23.85M	8.21M	32.06M	7.76
46	JIM BEAM BRANDS COMPANY	23.49M	7.93M	31.42M	7.64
6	BACARDI USA INC	17.43M	7.42M	24.85M	5.67
20	CONSTELLATION BRANDS INC	15.27M	8.95M	24.22M	4.97
11	BROWN-FORMAN CORP	13.24M	5.01M	18.25M	4.31
30	E & J GALLO WINERY	12.07M	6.33M	18.40M	3.93
106	ULTRA BEVERAGE COMPANY LLP	11.17M	5.34M	16.50M	3.63
53	M S WALKER INC	9.76M	4.94M	14.71M	3.18
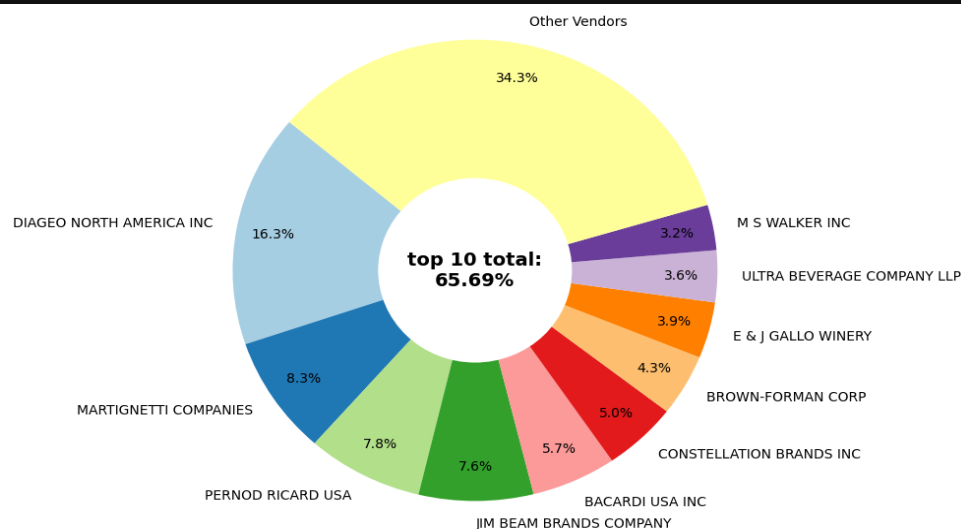
4. Impact of Bulk Purchasing on Cost Saving.

Vendors buying in large quantities receive a 72% lower unit cost ($10.78 per unit vs. higher unit cost in smaller orders).

Bulk pricing strategies encourage larger orders, increasing total sales while maintain profitability.

OrderSize	UnitPurchasePrice
Small	39.057543
Medium	15.486414
Large	10.777625

5. Identifying Vendors with Low Inventory Turnover

Total unsold Inventory Capital : $2.71 M

- Slow – Moving inventory increases storage costs, reduces cash flow efficiency, and affects overall profitability.
- Identifying vendors with low inventory turnover enables better stock management, minimizing financial strain.

VendorName	StockTurnover
ALISA CARR BEVERAGES	0.615385
HIGHLAND WINE MERCHANTS LLC	0.708333
PARK STREET IMPORTS LLC	0.751306
Circa Wines	0.755676
Dunn Wine Brokers	0.766022
CENTEUR IMPORTS LLC	0.773953
SMOKY QUARTZ DISTILLERY LLC	0.783835
TAMWORTH DISTILLING	0.797078
THE IMPORTED GRAPE LLC	0.807569
WALPOLE MTN VIEW WINERY	0.820548

	VendorName	UnsoldInventoryValue
25	DIAGEO NORTH AMERICA INC	722.21K
46	JIM BEAM BRANDS COMPANY	554.67K
68	PERNOD RICARD USA	470.63K
116	WILLIAM GRANT & SONS INC	401.96K
30	E & J GALLO WINERY	228.28K
79	SAZERAC CO INC	198.44K
11	BROWN-FORMAN CORP	177.73K
20	CONSTELLATION BRANDS INC	133.62K
61	MOET HENNESSY USA INC	126.48K
77	REMY COINTREAU USA INC	118.60K

6. **Profit Margin Comparison: High Vs. Low-Performing Vendors**
   Top Vendor's Profit Margin (95% CI): (30.74%,31.61%), Mean : 31.17%
   Low Vendor's Profit Margin (95%CI) : (40.48%,42.62%), Mean: 41.55%

   Lowe-Performing vendors maintain higher margins but struggle with sales volumes, indicating potential pricing inefficiencies or market reach issues.

   Actional Insights:

   Top-Performing Vendors : Optimize profitability by adjusting pricing, reducing operational costs, or offering bundled promotions.

   Low-Performing Vendors: Improve marketing efforts, optimize pricing strategies, and enhance distribution networks.

Confidence Interval Comparison: Top vs. Low Vendors (Profit Margin)
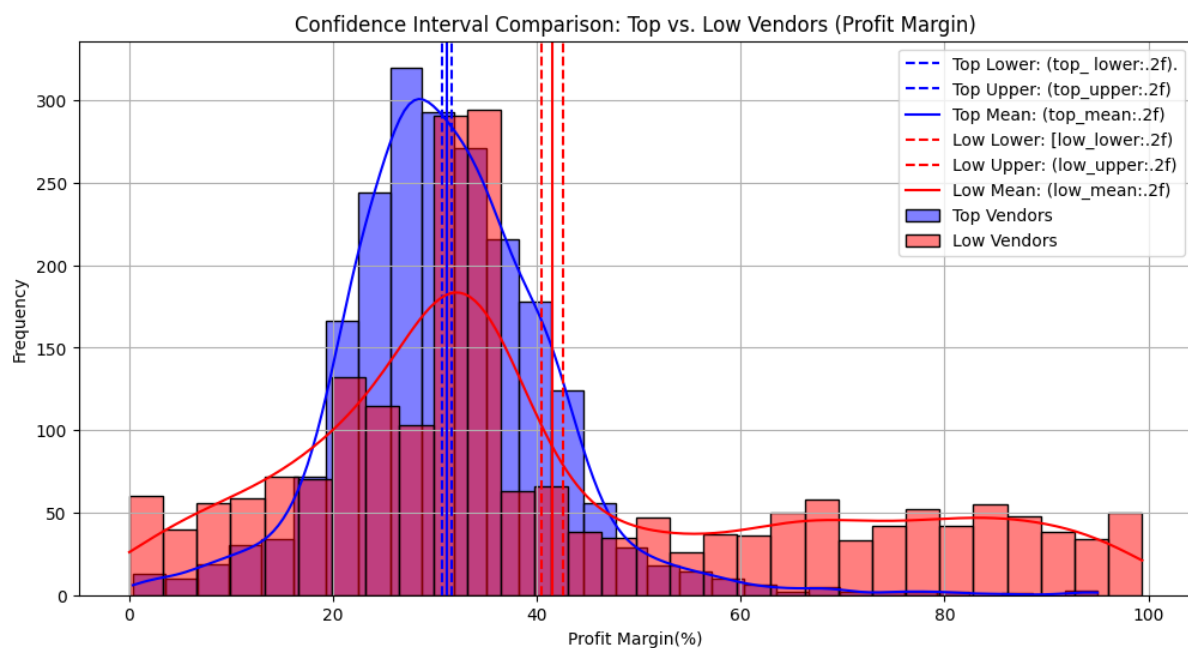
7. **Statical Validation of Profit Margin Difference**
   Hypothesis Testing:
   H_o (Null Hypothesis) : No Significant difference in profit margins between top and low-performing vendors.
   H_1 (Alternative Hypothesis): A significant difference exists in profit margins between the two vendors groups.

   Result: The null hypothesis is rejected, confirming that the two groups operate under distinctly different profitability models.

   Implicaiton: High-margin vendors may benefit from better pricing stratigies, while top-selling vendors could focus on cost efficiency.

POWER BI DASHBOARD

VENDOR SALES ANALYSIS

Total Sales ($)
441.41M

Total Purchase ($)
307.34M

Gross Profit ($)
134.07M

Profit Margin (%)
38.72

Unsold Capital ($)
2.71M

Top Brands By Sales

Jack Dani...
Tito's Han...
Grey Goos...
Capt Mor...
Absolut 8...
Jameson I...
Ketel One ...
Baileys Iris...
Kahlua
Tanqueray

Sum of TotalSalesDollars by VendorName

DIAGEO N...
MARTIGNE...
PERNOD RI...
JIM BEAM ...
BACARDI U...
CONSTELLA...
E & J GALL...
BROWN-FO...
ULTRA BEV...
M S WALKE...

Purchase Contribution %

M S WALKER... 3.18
E & J GALLO W... 3.93
BROWN-F... 4.31
CONSTE... 4.97
BACARDI USA... 5.67
JIM BEAM BRANDS COMP... 7.64
DIAGEO NORTH AME.. 16.30
MARTIGNET.. 8.30
PERNOD RICARD USA 7.76

Low Performing Vendors

Vendor	Value
WALPOLE MTN VIE...	0.82
THE IMPORTED GRA...	0.81
TAMWORTH DISTILL...	0.80
SMOKY QUARTZ DIS...	0.78
CENTEUR IMPORTS ...	0.77
Dunn Wine Brokers	0.77
Circa Wines	0.76
PARK STREET IMPO...	0.75
HIGHLAND WINE M...	0.71
ALISA CARR BEVERA...	0.62

Low Performing Brands

TargetBrand ● NO ● YES

Average Profit Margin

0   200   400   600   800   1,000
Total Sale

FINAL RECOMMENDATIONS

- ➢ Re-evaluate pricing for low-sales, high-margin brands to boost sales volume without sacrificing profitability.
- ➢ Diversify vendor partnerships to reduce dependency on a few suppliers and mitigate supply chain risks.
- ➢ Leverage bulk purchasing advantages to maintain competitive pricing while optimizing inventory management.
- ➢ Optimize slow-moving inventory by adjusting purchase quantities, launching clearance sales, or revising storage strategies.
- ➢ Enhance marketing and distribution strategies for low-performing vendors to drive higher sales volumes without compromising profit margins.
- ➢ By implementing these recommendations, the company can achieve sustainable profitability, mitigate risks, and enhance overall operational efficiency.