PROJECT: VENDOR PERFORMANCE ANALYSIS

BUSINESS PROBLEM:

The company lacks deep analytical insights into vendor and brand performance across key areas such as sales contribution, profitability, inventory efficiency, and cost optimization.

Ineffective promotional strategies, excess stock, and unoptimized purchasing volumes are impacting procurement efficiency and profitability. There is a pressing need to identify high-performing vendors, optimize procurement strategies, and make data-driven decisions based on sales trends, inventory behavior, and profit margins.

PROJECT OBJECTIVE:

- Analyse vendor and brand performance based on sales, profit margins, inventory turnover, and purchase value.
- Identify top-performing vendors and brands with high sales and profitability.
- Detect underperforming products that have low sales but high profit margins for pricing or promotional strategies.
- Evaluate how bulk purchasing affects unit prices and find the optimal purchase volume for cost savings.
- Identify vendors contributing to excess inventory and capital lock-in.
- Perform statistical analysis to compare profit margins between top and low-performing vendors.

DATASET REVIEW:

The analysis is based on six interconnected tables, present in vendors database that cover various aspects of the vendor and product performance:

- **Vendors invoice** – Includes vendor information such as vendor IDs, vendor names, invoice date, PO number, PO date, Quantity, dollars, Freight & Approval.
- **Purchase Price** – Lists all Vendor names, their IDs, associated brand and, unit price, and Purchase price.
- **Begin inventory & End inventory** – Tracks current inventory id, brands, sizes, prices & dates, levels of each product, helping identify excess or slow-moving inventory.
- **Purchases** – Records purchase transactions including purchase dates, quantities, size and purchase prices per vendor. Including pay date, receive date, vendor name, vendor ID, associated brands.

- **sales.csv** – Contains detailed sales data like sales volume, sales quantity, sales dollars, sales price, excise tax and dates. Including vendor name, vendor Id, and brands description.

Together, these datasets provide a complete view of procurement, sales, inventory, and vendor effectiveness. By analysing all the tables, we conclude that:

1. The Purchases table contains actual purchase data, including the date of purchase, products (brands) Purchased by vendors, the amount paid (in dollars), and the quantity purchased.
2. The purchase price column is derived from the purchase price table, which provides product-wise actual and purchase prices. The combination of vendor and brand is unique in the table.
3. The Vendor invoice table aggregates data from the purchases table, summarising Quantity and dollar amounts, along with an additional column for freight. The table maintains uniqueness based on vendors and Po number.
4. The Sales table Captures actual sales transaction, detailing the brands purchased by vendors, the quantity sold, the selling price and the revenue earned.

RESEARCH QUESTIONS (based on business problem):

1. Identify Brands that need Promotional or Pricing Adjustment Which exhibit low sales performance but higher profit margins.

2. Which Vendors and Brands demonstrate the high sales performance?

3. Which Vendor Contributes the most to the total Purchase Dollars?

4. How much of total Procurement(Purchase) is depend on the top vendors?

5. Does Purchasing in Bulk reduce the unit price, and what is the optional Purchase volume for cost savings?

6. Which Vendors have low inventory turnover, indicating excess stock and slow-moving product?

7. How Much Capital is locked in Unsold inventory per vendor and which vendors contribute the most?

8. What is the 95% Confidence intervals for Profit Margin of top-performing & low-performing Vendors?

9. Is there a significant difference in Profit margins between top-performing & low-performing vendors?

EDA (Exploratory Data Analysis):

Summary statistics:

	count	mean	std	min	25%	50%	75%	max
VendorNumber	10692.0	10650.649458	18753.519148	2.000000	3951.000000	7153.000000	9552.000000	2.013590e+05
Brand	10692.0	18039.228769	12662.187074	58.000000	5793.500000	18761.500000	25514.250000	9.063100e+04
purchase_price	10692.0	24.385303	109.269375	0.360000	6.840000	10.455000	19.482500	5.681810e+03
volume	10692.0	847.360550	664.309212	50.000000	750.000000	750.000000	750.000000	2.000000e+04
actual_price	10692.0	35.643671	148.246016	0.490000	10.990000	15.990000	28.990000	7.499990e+03
total_purchase_quantity	10692.0	3140.886831	11095.086769	1.000000	36.000000	262.000000	1975.750000	3.376600e+05
total_purchase_dollars	10692.0	30106.693372	123067.799627	0.710000	453.457500	3655.465000	20738.245000	3.811252e+06
total_sales_quantity	10692.0	3077.482136	10952.851391	0.000000	33.000000	261.000000	1929.250000	3.349390e+05
total_sales_dollars	10692.0	42239.074419	167655.265984	0.000000	729.220000	5298.045000	28396.915000	5.101920e+06
total_sales_price	10692.0	18793.783627	44952.773386	0.000000	289.710000	2857.800000	16059.562500	6.728193e+05
total_exice_tax	10692.0	1774.226259	10975.582240	0.000000	4.800000	46.570000	418.650000	3.682428e+05
fright_cost	10692.0	61433.763214	60938.458032	0.090000	14069.870000	50293.620000	79528.990000	2.570321e+05
Gross_Profit	10692.0	12132.381048	46224.337964	-52002.780000	52.920000	1399.640000	8660.200000	1.290668e+06
Profit_Margin	10692.0	-14.218476	443.735627	-23730.638953	15.990615	31.027031	41.086060	9.971666e+01
Stock_Turn_Over	10692.0	1.706793	6.020460	0.000000	0.807229	0.981529	1.039342	2.745000e+02
Sales_Purchase_Ratio	10692.0	2.504390	8.459067	0.000000	1.153729	1.436894	1.665449	3.529286e+02
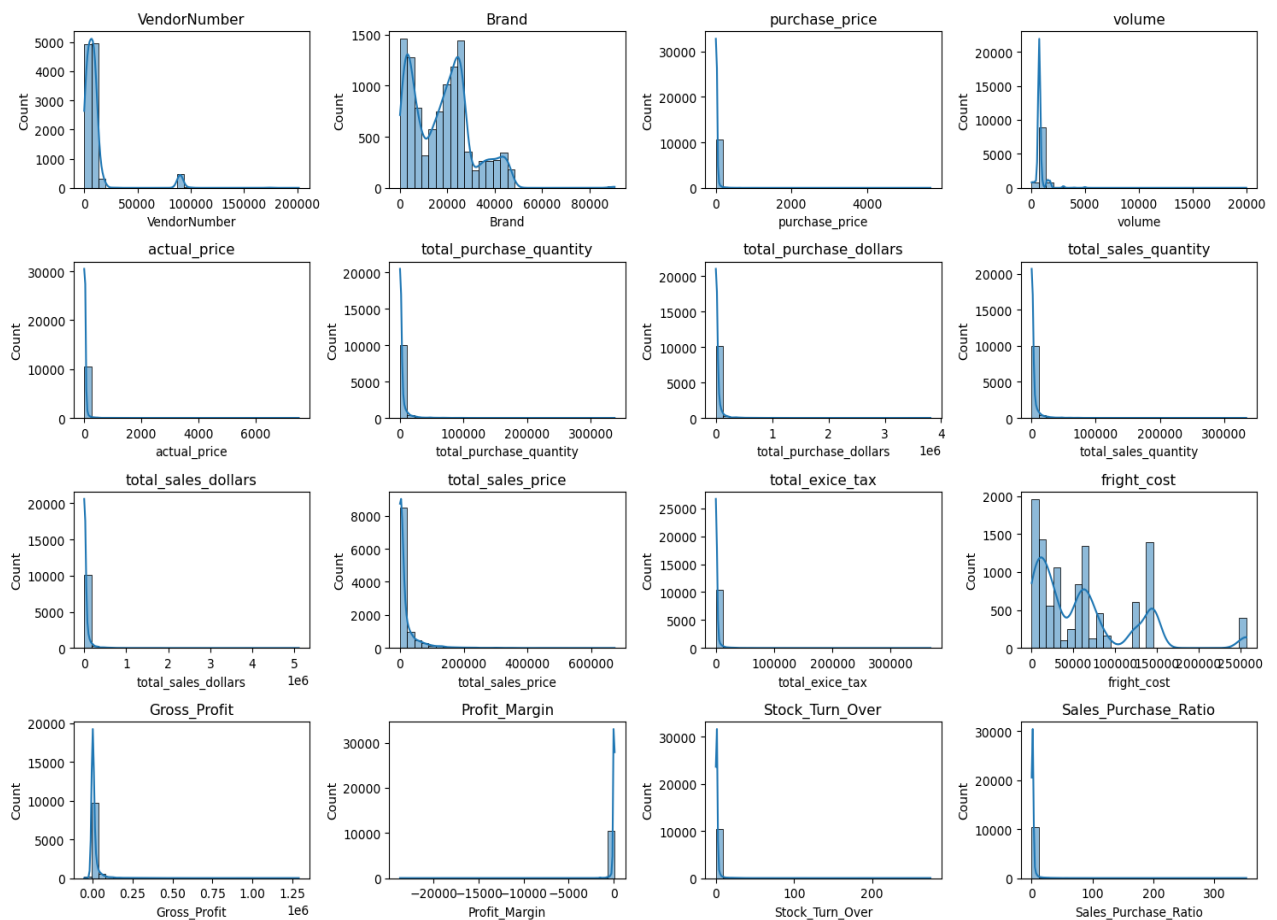
Statistical summary analysis:

1. Gross Profit: Minimum Value is -52,002.78, indicating potential losses. Some Products or transactions may be selling at a loss due to high costs or selling at discounts lower than the Purchase Price.

2. Profit Margin: Has a minimum of -23730.63, which suggest cases where revenue is zero or even lower than costs leading to extreme negative profit margins.

3. Total sales Quantity & 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:

1. Purchase & Actual Prices: The max values (5,681.81 & 7,499.99) are significantly higher than the mean(24.39 & 35.64), indicating Potential premium products offerings.

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

3. Stock Turnover: Ranges from 0 to 274.5, suggesting some products sell rapidly fast while others remain unsold for long periods. A Value greater than 1 indicates that sales for a product is exceed purchased quantity due to older stocks fulfilling orders.

<u>DATA FILTERING</u>:

To enhance the reliability, 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 eliminate inventory that was never sold)

CORRELATION INSIGHTS:

Correlation Heatmap

	VendorNumber	Brand	purchase_price	volume	actual_price	total_purchase_quantity	total_purchase_dollars	total_sales_quantity	total_sales_dollars	total_sales_price	total_exice_tax	fright_cost	Gross_Profit	Profit_Margin	Stock_Turn_Over	Sales_Purchase_Ratio
VendorNumber	1.00	0.08	-0.02	0.00	-0.02	-0.06	-0.05	-0.06	-0.05	-0.07	-0.03	-0.21	-0.06	-0.02	-0.00	-0.00
Brand	0.08	1.00	-0.04	-0.00	-0.02	-0.14	-0.15	-0.14	-0.15	-0.25	-0.16	-0.16	-0.13	0.07	-0.02	-0.01
purchase_price	-0.02	-0.04	1.00	0.03	0.99	-0.05	-0.01	-0.05	-0.01	-0.01	-0.02	-0.00	-0.02	0.04	0.00	0.00
volume	0.00	-0.00	0.03	1.00	0.03	0.01	0.10	0.01	0.10	0.14	0.13	-0.02	0.10	-0.06	-0.04	-0.04
actual_price	-0.02	-0.02	0.99	0.03	1.00	-0.05	-0.01	-0.05	-0.02	-0.01	-0.02	-0.00	-0.02	0.05	0.00	0.00
total_purchase_quantity	-0.06	-0.14	-0.05	0.01	-0.05	1.00	0.67	1.00	0.69	0.55	0.62	0.17	0.69	-0.12	-0.05	-0.05
total_purchase_dollars	-0.05	-0.15	-0.01	0.10	-0.01	0.67	1.00	0.67	1.00	0.82	0.88	0.15	0.96	-0.12	-0.04	-0.04
total_sales_quantity	-0.06	-0.14	-0.05	0.01	-0.05	1.00	0.67	1.00	0.68	0.54	0.62	0.17	0.70	-0.11	-0.04	-0.05
total_sales_dollars	-0.05	-0.15	-0.01	0.10	-0.02	0.69	1.00	0.68	1.00	0.83	0.87	0.15	0.98	-0.11	-0.04	-0.04
total_sales_price	-0.07	-0.25	-0.01	0.14	-0.01	0.55	0.82	0.54	0.83	1.00	0.67	0.20	0.81	-0.18	-0.07	-0.07
total_exice_tax	-0.03	-0.16	-0.02	0.13	-0.02	0.62	0.88	0.62	0.87	0.67	1.00	0.13	0.82	-0.09	-0.03	-0.03
fright_cost	-0.21	-0.16	-0.00	-0.02	-0.00	0.17	0.15	0.17	0.15	0.20	0.13	1.00	0.14	-0.01	0.00	0.00
Gross_Profit	-0.06	-0.13	-0.02	0.10	-0.02	0.69	0.96	0.70	0.98	0.81	0.82	0.14	1.00	-0.07	-0.04	-0.04
Profit_Margin	-0.02	0.07	0.04	-0.06	0.05	-0.12	-0.12	-0.11	-0.11	-0.18	-0.09	-0.01	-0.07	1.00	0.40	0.42
Stock_Turn_Over	-0.00	-0.02	0.00	-0.04	0.00	-0.05	-0.04	-0.04	-0.04	-0.07	-0.03	0.00	-0.04	0.40	1.00	1.00
Sales_Purchase_Ratio	-0.00	-0.01	0.00	-0.04	0.00	-0.05	-0.04	-0.05	-0.04	-0.07	-0.03	0.00	-0.04	0.42	1.00	1.00

Purchase Price vs. Total Sales Dollars & Gross Profit: weak correlation with Total Sales Dollars (-0.01) and Gross Profit (-0.02), indicating that price variation do not significantly impact sales revenue or profit.

Total Purchase Quantity vs. Total Sales Quantity: Strong correlation between purchase quantity and total sales quantity (0.999), confirming efficient inventory turnover.

Profit margin & Total Sales Price: Negative correlation (-0.18) suggests that increasing sales price may lead to reduce margins, possibly due to competitive pricing pressure.

Stock Turnover vs. Gross Profit vs. Total Purchase Quantity: weak negative correlation with both gross profit (-0.04) and Total Purchase Quantity (-0.05) indicating the faster turnover does not necessarily result in higher Profitability.

## RESEARCH QUESTIONS & KEY FINDINGS:

1. Brands for Promotional or Price Adjustments:

Brands With Low Sales but High Profit Margin

	Description	total_sales_dollars	Profit_Margin
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 exhibits lower Sales but higher profit margins, which could benefit from targeted marketing, promotions, or price optimization to increase volume without compromising profitability.
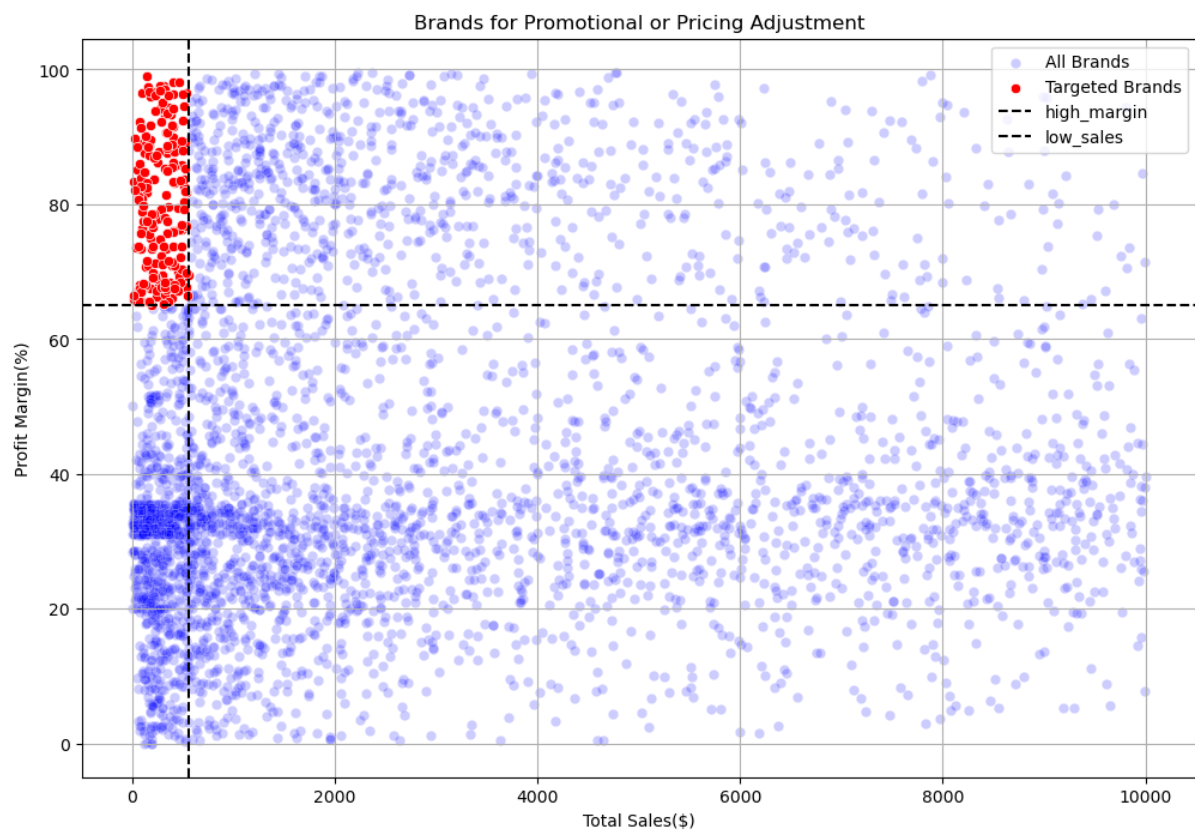
2. Top Vendors by sales & Purchase Contribution:

The top 10 vendors contribute 65.69% of total Purchase, 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.

Top 10 Vendors Purchase contribution (%)
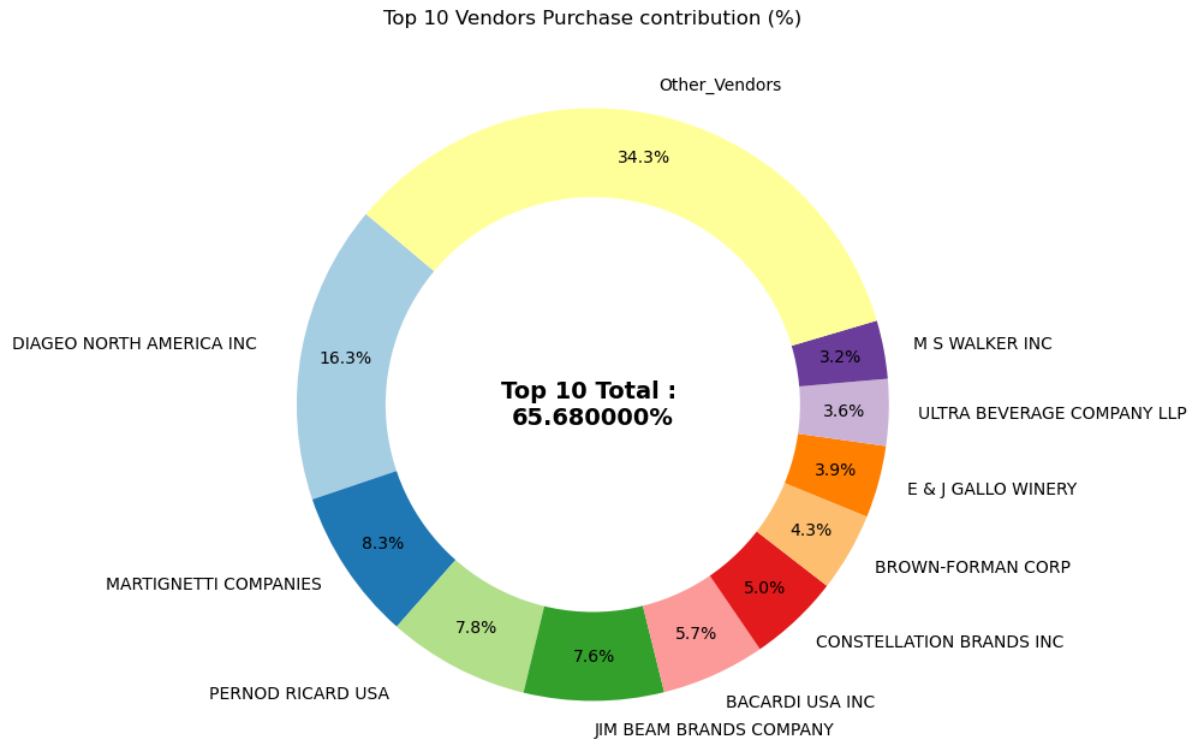
3. Impact of Bulk Purchasing on Cost Saving:

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

Bulk Pricing Strategies encourage large orders, increasing total sales while maintaining profitability.

order_size	unit_purchase_price
small	39.057543
medium	15.486414
large	10.777625

4. Identifying Vendors with Low Inventory Turnover:

Total unsold inventory Capital: $2.71M

Slow-moving inventory increases Storage costs, reduce cash flow efficiency, and affects overall profitability.

Identify Vendors with low inventory turnover enables better stock management, minimizing, financial strain.

	VendorName	Stock_Turn_Over			VendorName	unsold_inventory_value
0	ALISA CARR BEVERAGES	0.615385		25	DIAGEO NORTH AMERICA INC	722209.05
1	HIGHLAND WINE MERCHANTS LLC	0.708333		46	JIM BEAM BRANDS COMPANY	554665.63
2	PARK STREET IMPORTS LLC	0.751306		69	PERNOD RICARD USA	470625.61
3	Circa Wines	0.755676		117	WILLIAM GRANT & SONS INC	401960.83
4	Dunn Wine Brokers	0.766022		30	E & J GALLO WINERY	228282.61
5	CENTEUR IMPORTS LLC	0.773953		80	SAZERAC CO INC	198436.41
6	SMOKY QUARTZ DISTILLERY LLC	0.783835		11	BROWN-FORMAN CORP	177733.74
7	TAMWORTH DISTILLING	0.797078		20	CONSTELLATION BRANDS INC	133617.62
8	THE IMPORTED GRAPE LLC	0.807569		62	MOET HENNESSY USA INC	126477.70
9	WALPOLE MTN VIEW WINERY	0.820548		78	REMY COINTREAU USA INC	118598.15

5. Profit Margin Comparison: High vs. Low-Performing Vendors.

Top Vendors profit Margin (95% CI): (31.07%, 31.49%), mean: 31.49

Low Vendor Profit Margin (95%CI): (38.05%, 40.42%), mean: 39.24

Low performing Vendors maintain higher margins but struggle with sales volumes, indicating potential pricing inefficiencies or market reach issues.

Actionable Insights:

1. Top- performing vendors: Optimize Profitability by adjusting pricing, reducing operational costs, or offering bundled promotions.

2. Low performing vendors: Improve marketing efforts, optimize pricing strategies, and enhance distribution networks.

Confidence Interval Comparison: Top vs. Low Vendors (Profit Margin)
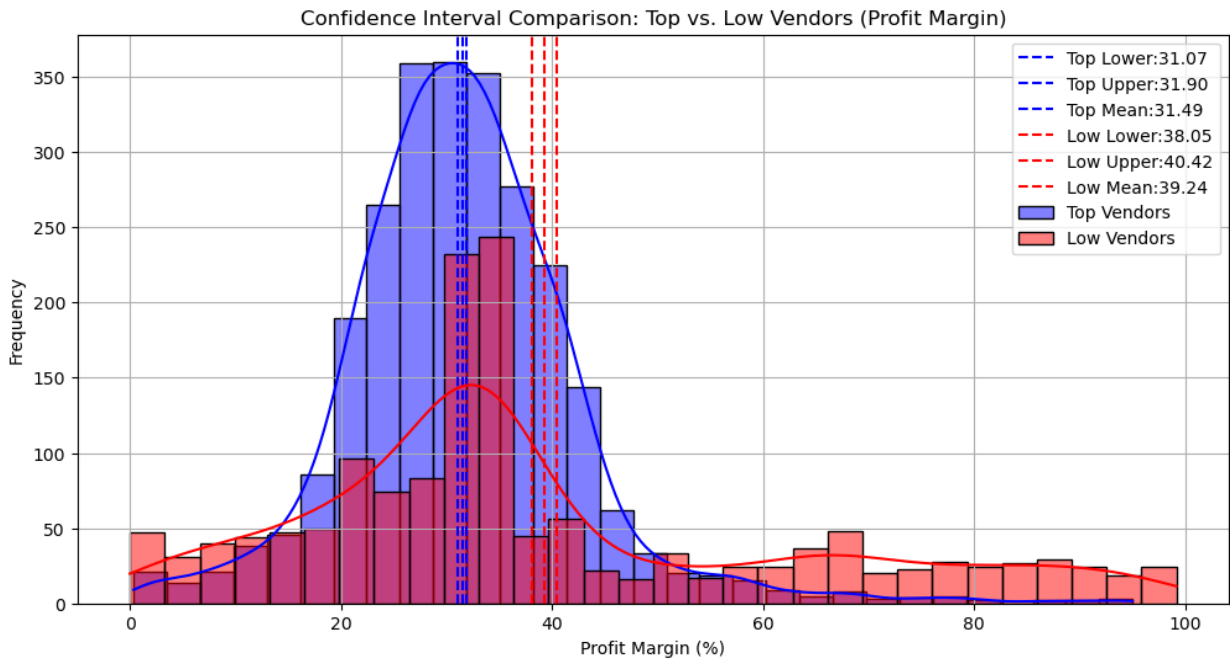
6. Statistical Validation of Profit Margin Differences:

   Ho (Null Hypothesis): There is no significant difference in the mean profit margins of top-performing and low-performing vendors.

   H1 (Alternative Hypothesis): The mean Profit margins of top-performing and low-performing Vendors are significantly different.

RESULT: The Null Hypothesis is rejected, confirming that the two groups operate under distinctly different profitability models.

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

FINAL RECOMMENDATIONS:

1. Re-evaluate Pricing for low-sales, high-margin brands to boost sales volume without sacrificing profitability.

2. Diversify vendor partnership to reduce dependency on a few suppliers and mitigate supply chain risks.

3. Leverage bulk purchasing advantages to maintain competitive pricing while optimizing inventory management.

4. Enhance marketing and distribution strategies for low-performing vendors to drive higher sales volumes without compromising profit margins.

          By implementing these recommendation, the company can achieve sustainable profitability, mitigate risks, and enhance overall operational efficiency.