

## AMAZAVR SUPPLIER ANALYSIS: RESEARCH PLAN AND ANALYTICAL APPROACH

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### OBJECTIVE

**The objective** of this research is to analyze supplier performance with a specific focus on supplier dependency and its impact on business operations. The study evaluates profitability, supplier diversity, supplier dependence and associated risks to ensure strategic alignment with business goals.

**Key goals** include:

1. Assessing supplier dependency and categorizing suppliers based on risk profiles.
2. Identifying suppliers' revenue contribution to the business.
3. Calculating and assessing supplier diversity using the Herfindahl-Hirschman Index (HHI) across product categories.
4. Evaluating the relationship between supplier dependency, revenue contributions, defect rates and storage costs.
5. Assessing the role of suppliers in supply chain by using Supply Chain Criticality Score (SCCS) and supplier risk by using Supplier Risk Factor (SRF).
6. Providing **actionable insights** to guide decision-making based on supplier dependency and performance metrics.

### RESEARCH QUESTIONS

1. How many unique suppliers does the company have, and what is the distribution across product categories?
2. How much revenue do suppliers contribute to the business, and what percentage of total revenue do they represent?
3. What is the average supplier dependency percentage, and which suppliers have the highest dependency levels?
4. How does this dependency vary across categories?
5. What is the supplier diversity across product categories, and what does it reveal about supply chain concentration?
6. What is the relationship between supplier dependency and discounting practices?
7. What proportion of units from each supplier are defective (incl. across product categories), and which suppliers have the highest defect rates?
8. What are the storage costs for the goods of each supplier (incl. across product categories), and which suppliers have the highest storage costs?
9. Which suppliers fall into high-risk or high-opportunity categories based on storage costs and defect rates?
10. How can the categorization of suppliers into strategic financial and risk profiles guide strategic decisions and operational improvements?

### KEY STEPS

1. **Data Exploration and Cleaning**
  - Inspect the dataset for completeness
  - Standardize numerical and categorical fields

- Clean the data, ensuring proper formatting (e.g., converting dates).
- Validate numerical values (e.g., check for negative values in stock or sales data).

### 2. Revenue Analysis by Supplier

- Calculate total and average revenue per supplier.
- Assess revenue share for each supplier and its contribution to overall business performance.

### 3. Supplier Dependency Analysis

- Using supplier dependency index for each supplier, highlight suppliers with dependency levels exceeding 50%, marking them as critical.
- Establish supplier dependency across principal product categories.

### 4. Supplier Diversity Analysis (HHI)

- Compute and interpret the Herfindahl-Hirschman Index to assess supplier concentration, both overall and across principal product categories.
- Compute and interpret the Strategic Supply Concentration Index (SSCI) to evaluate the focus of a supplier's contributions in terms of revenue and product diversity.

### 5. Risk Categorization Framework

- Analyze defect rates and storage costs across all suppliers.
- Categorize suppliers into four groups based on revenue contribution, storage costs, and supplier dependency (strategic criticality)
- Categorize suppliers into four groups based on average defect rates and storage costs, with a focus on supplier dependency as an additional filter (supply risk factor).
- Prioritize suppliers based on their dependency and risk profiles.
- Propose a real-time ML solution to automate and improve supplier performance monitoring, minimizing potential negative impacts.

### 6. Visualizations and Reporting

- Develop visual tools (such as scatter plots) to illustrate supplier categorization, dependency, and financial metrics.
- Provide insights and recommendations based on the categorization analysis.

## ASSUMPTIONS AND METHODOLOGY

### 1. Data Assumptions:

- The reported data is considered genuine, conforms to major reporting standards, and includes pre-calculated KPIs such as monthly revenue and Supplier Dependency Index, which do not require recalculation. While minor inaccuracies or cleaning needs may exist, the data is deemed reliable for analysis.
- As monthly revenue provided in the dataset is equal to the product of provided monthly sales and unit price, it should not be adjusted for provided discount rates, since they are already factored into the unit price.

- Average lines for market shares and storage cost ratio are used as thresholds for economic value categorization of suppliers.
- Average lines for defect rates and storage costs are used as thresholds for risk categorization of suppliers.

## 2. Supplier Diversity: Herfindahl-Hirschman Index (HHI)

$$HHI = \sum_{i=1}^N \left( \frac{R_i}{R_{total}} \right)^2$$

Where:

- $R_i$  = Revenue generated by supplier i
- $R_{total}$  = Total revenue across all suppliers

This formula calculates the level of concentration in the supply base:

- An HHI closer to 1 indicates high concentration (few suppliers dominate), and an HHI closer to 0 suggests a more diverse supply base.
- A higher HHI suggests higher risk in case of supply chain disruption. A lower HHI indicates a better risk resilience.

Actionable Insights from Supplier Diversity:

- High HHI: Consider increasing the number of suppliers to mitigate over-reliance on a few vendors.
- Low HHI: Ensure continued stability and maintain strong relationships with existing suppliers.

## 3. Strategic Supply Concentration Index (SSCI)

$$SSCI = \sum_{i=1}^n \left( \frac{P_i}{P_{total}} \times \frac{R_i}{R_{total}} \right)$$

Where:

- $P_i$  = Number of products contributed by supplier i
- $P_{total}$  = Total number of products across all suppliers.
- $R_i$  = Revenue generated by supplier ii.
- $R_{total}$  = Total revenue across all suppliers.

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This formula calculates the degree of concentration of supplier contributions in terms of both product diversity and revenue:

- High SSCI value indicates a supplier's contributions are concentrated in terms of revenue and product diversity. This suggests a higher dependency on this supplier for critical product lines, increasing potential risks.
- Low SSCI value indicates a more balanced contribution across suppliers, reducing dependency on any single supplier. This suggests better resilience against supply chain disruptions.

For better perception, this index needs to be normalized.

Actionable Insights from SSCI:

- High SSCI: Consider reducing reliance on critical suppliers by spreading production across multiple vendors.
- Low SSCI: Strengthen relationships with diverse suppliers to maintain resilience and stability in the supply chain.

#### 4. Supplier Dependency:

Supplier Dependency and Discount Rate are the metrics available in the dataset. We assume that the Supplier Index provided is calculated as the measure of a buyer's reliance on a particular supplier (spend on supplier / total spend).

#### 5. The Cost Efficiency Analysis:

The cost efficiency analysis of suppliers will be assessed by the following formula:

$$C_{\text{efficiency}} = \left( Q \cdot P \cdot \left( 1 - \frac{D}{100} \right) \right) + C_{\text{storage}}$$

Where:

- $C_{\text{efficiency}}$  = Cost of efficiency for the supplier
- $Q$  = Quantity of stock supplied
- $P$  = Unit price of the product
- $D$  = Discount percentage offered by the supplier
- $C_{\text{storage}}$  = Storage cost per unit

Storage cost metrics are calculated as follows:

Storage Cost = Stock Quantity × Cost per Unit of Stock per Day

Storage Cost Ratio = Total Storage Cost / Monthly Revenue × 100

#### 6. Quality Analysis:

In order to assess the product quality status of suppliers, the following metrics are used:

- Defect Rate (Defective Units as % of the Stock Quantity)
- Total Defect-Associated Loss (Number of Defected Units x Sales Price)
- Defect-Associated Loss Ratio (Defect-Associated Loss as % Total Revenue)

### 7. Strategic Supplier Analysis:

The Supply Chain Criticality Score (SCCS) provides a metric to evaluate how strategically important each supplier is to the business, considering revenue contribution, cost efficiency, and dependency. It estimates strategic importance by incorporating risk and financial factors:

$$\text{SCCS} = \text{Supplier Dependency} \times (\text{Revenue Share/Storage Cost Ratio})$$

Interpretation of SCCS:

- High SCCS Value: Indicates a strategically important supplier with high dependency and revenue contribution, balanced by low storage costs. These suppliers are critical to the business's operations and should be managed carefully.
- Low SCCS Value: Suggests that a supplier contributes less to strategic goals due to lower dependency, revenue share, or disproportionately high storage costs.

Actionable Insights from SCCS:

- High SCCS: Consider risk mitigation, ensure continuity of supply through long-term contracts and prioritize investment in relationships and infrastructure that enhance engagement with high-SCCS suppliers.
- Low SCCS: Reduce over-reliance on suppliers with low SCCS by reallocating resources to higher-SCCS suppliers and evaluate the necessity of maintaining relationships with suppliers that score low on SCCS to streamline the supply chain.

**Visual Matrix (Scatterplot):** Suppliers will be additionally assessed based on revenue share (Y-axis), storage cost ratio (X-axis), and supplier dependency (bubble size), focusing on the economic value and the importance of each supplier to the business.

### 8. Strategic Supplier Risk Analysis

**Supplier Risk Factor (SRF)** is a metric designed to evaluate the overall risk associated with each supplier, combining quality risk, cost-efficiency, and supplier dependency into a single score. By considering the percentage of defective units, storage cost efficiency, and the business's dependency on the supplier, SRF provides a nuanced understanding of supplier-related risks:

$$\text{SRF} = (\text{Defective Unit Rate} + \text{Storage Cost Ratio}) \times (1 + \text{Supplier Dependency})$$

Interpretation of SRF:

- High SRF: Indicates suppliers that pose significant risks due to quality issues (high defective unit rates), inefficiencies in inventory management (high storage cost ratios), or critical dependency.
- Low SRF Value: Suggests suppliers with minimal risk, characterized by better quality, cost efficiency, or lower business dependency. These suppliers are more stable and require less intensive management.

**Actionable Insights from SRF:**

- **High SRF Suppliers:**
  - Evaluate quality improvement initiatives to reduce defect rates.
  - Negotiate better terms to lower storage costs or improve cost efficiency.
  - Develop contingency plans to mitigate risks associated with high dependency, such as finding alternative suppliers or diversifying sourcing strategies.
- **Low SRF Suppliers:**
  - Strengthen partnerships to maximize the benefits of working with reliable and cost-efficient suppliers.
  - Allocate resources strategically to ensure consistent performance and maintain low-risk levels.

**Visual Representation (Scatterplot):** The scatterplot will depict suppliers' positions, with the X-axis representing the Storage Cost Ratio (indicating cost-efficiency risk) and the Y-axis representing the Defective Unit Rate (indicating quality risk). The bubble size will correspond to Supplier Dependency. This visualization highlights suppliers that exhibit both high risk and high dependency, enabling the decision makers to prioritize efforts on mitigating the most significant threats to its supply chain.

**EXPECTED OUTCOMES AND ACTIONABLE INSIGHTS**

This research is to identify key suppliers that require more strategic focus based on their dependency, risk, and profitability. The findings are expected to enable decision-makers to prioritize:

- Renegotiating contracts with high-risk suppliers
- Strengthening relationships with low-risk suppliers
- Optimizing the supplier base for greater diversity and reduced concentration risk

These insights will serve as actionable guidance for improving supplier performance, optimizing costs, and ensuring the long-term stability of the supply chain.