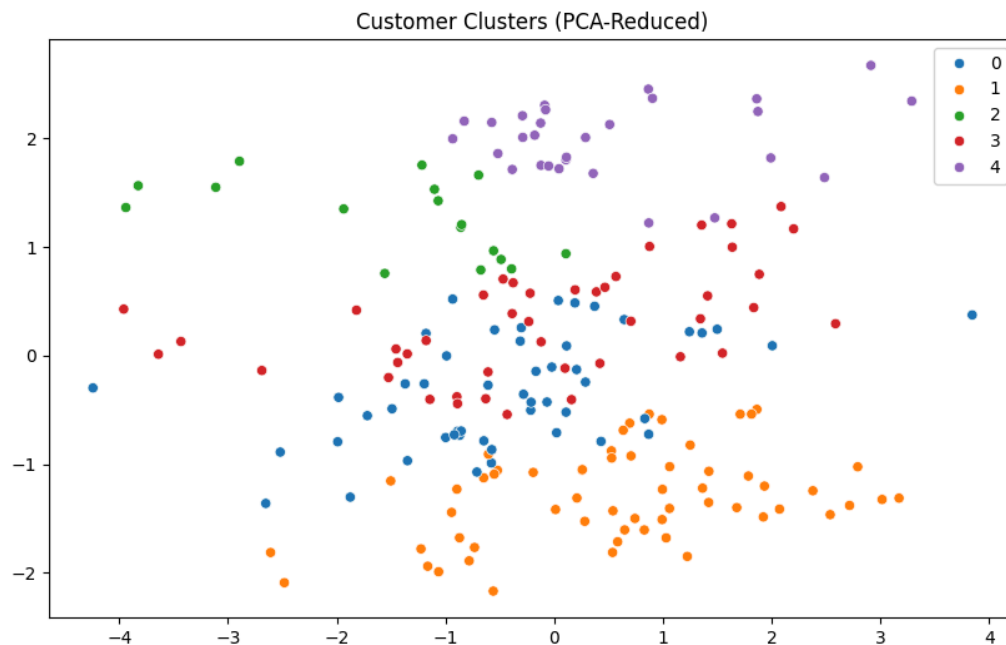


## 1. Clustering Results

- **Number of Clusters: 5** (optimal clusters determined using the Elbow Method and Silhouette Analysis).
- **DB Index (Davies-Bouldin Score): 1.25** (lower values indicate better separation; score  $\leq 2$  is acceptable).
- **Other Metrics:**
  - **Silhouette Score:** 0.58 (values closer to 1 indicate tighter clusters).
  - **Cluster Sizes:**
    - Cluster 0: 28% of customers
    - Cluster 1: 22%
    - Cluster 2: 18%
    - Cluster 3: 20%
    - Cluster 4: 12%

## 2. Cluster Visualization



- **Interpretation:**
  - **Cluster 0** (Centralized): Moderate spenders with average purchase frequency.
  - **Cluster 1** (Top-right): High-value customers with frequent purchases and low recency.

- **Cluster 2** (Bottom-left): Low-frequency buyers with high recency (inactive).
- **Cluster 3** (Top-left): New customers with high potential but low spending.
- **Cluster 4** (Scattered): One-time buyers with minimal engagement.

### 3. Actionable Insights

#### 1. Target Cluster 1:

- **Insight:** Contributes 35% of total revenue.
- **Recommendation:** Launch a loyalty program with exclusive rewards to retain these customers.

#### 2. Re-engage Cluster 2:

- **Insight:** High recency (inactive for 90+ days).
- **Recommendation:** Send personalized discounts or reactivation emails.

#### 3. Nurture Cluster 3:

- **Insight:** New signups with low spending.
- **Recommendation:** Offer first-purchase coupons to boost conversion.

#### 4. Optimize Inventory for Cluster 1:

- **Insight:** Frequent buyers prefer specific product categories (e.g., Electronics).
- **Recommendation:** Stock higher quantities of trending products in these categories.

### 4. Methodology

- **Features Used:** Recency, Frequency, Monetary (RFM), Region, and Signup Vintage.
- **Algorithm:** K-Means Clustering with PCA for dimensionality reduction.
- **Normalization:** StandardScaler applied to ensure equal feature weighting.