

Clustering Results and Insights

1. Number of Clusters Formed

- Optimal number of clusters: **4**, based on lowest **DB Index** (0.90) and highest **Silhouette Score** (0.34).
 - Increasing clusters beyond 4 reduced clustering quality.
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2. Clustering Metrics

- **Davies-Bouldin Index (DB Index):**
 - Measures cluster quality; lower values are better.
 - Optimal DB Index: **0.90** (at 4 clusters).
 - **Silhouette Score:**
 - Measures separation and cohesion; higher scores are better.
 - Optimal Score: **0.34** (at 4 clusters).
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3. Visual Representation of Clusters

- **PCA Plot:** Distinct separation between 4 clusters in reduced feature space.
 - **t-SNE Plot:** Reinforces clustering with clear group separations.
 - **Pie Chart:** Shows uneven customer distribution across clusters, with some larger clusters indicating common customer types.
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Key Observations

1. **Optimal Clustering:**
 - 4 clusters provide the best balance of separation and cohesion.
 2. **Distinct Customer Groups:**
 - PCA and t-SNE visualizations confirm the existence of unique customer segments.
 3. **Cluster Sizes:**
 - Uneven distribution indicates both large common groups and smaller niche segments.
 4. **Actionable Applications:**
 - Use clusters to tailor marketing, product recommendations, and services.
 - Larger clusters can guide mainstream strategies; smaller clusters may target niche needs.
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Additional Insights

- **Cluster Characteristics:** Identify demographics and spending patterns within clusters.
- **Business Applications:** Customize strategies and support to match each segment.
- **Imbalance in Sizes:** Address major customer groups while leveraging insights from smaller segments.