
Beyond the Product: A Data-Driven Approach at Packaging

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APPROACH

A modular, end-to-end pipeline transforms raw, unstructured customer reviews into actionable insights for packaging. The process is structured in five main stages:

Data Selection and Preprocessing

Raw reviews and metadata are loaded, duplicates are removed, and regular expressions are used to clean the text. Star ratings are mapped to sentiment labels; keywords flag packaging issues. A balanced dataset is created to ensure robust, unbiased model training.

Multi-Task Modeling

A fine-tuned microsoft/DeBERTa-v3 with LORA model simultaneously handles sentiment analysis and TF IDF with Logistic Regression for packaging issue detection. Hypertuning and early stopping optimize training; both tasks benefit from shared data. Model evaluation utilizes confusion matrices, precision, recall, accuracy and F1 Scores.

Clustering and Summarization

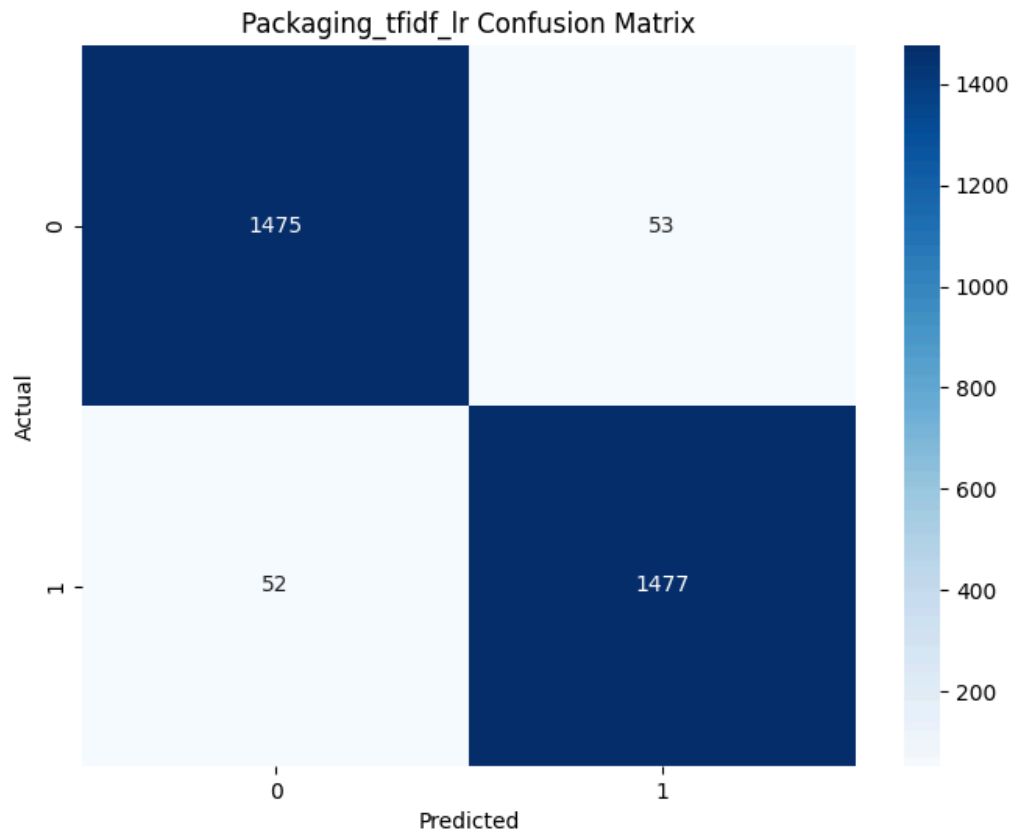
Model predictions using HBDBSCAN and rule group reviews are categorized into 4-6 meta-categories. Embeddings and clustering (e.g., all-mpnet-base-v2 and distilled-bert-case-uncased) visualize clusters, while t-SNE facilitates dimensionality reduction. Generative AI (GPT 3.5-turbo-0125 and fallback gpt4o) summarizes key review subsets, especially flagged packaging issues, for manager consumption.

Dashboard Deployment

Trained models, preprocessed data, and the Streamlit dashboard are packaged in a GitHub repo for easy manager access. The dashboard highlights packaging issue rates, sentiment breakdowns, and cluster insights.

RESULTS

- *The multi-task model demonstrates exceptional performance, achieving an F1-score of 0.96 in packaging issue detection, with a remarkable level of precision. This robust model instills confidence in its ability to identify packaging issues effectively.*
- *Sentiment analysis accuracy ranges from 65-75%, with neutral reviews as the main challenge. Packaging was the focus, so this can be improved later on.*
- *Clustering consistently produces high-purity meta-categories (0.85–0.95), and chi-square analysis confirms strong links between packaging issues (e.g., “leaked liquid”) and product types. This high level of accuracy provides reassurance about the thoroughness of the analysis.*
- *The Top Packaging issues are damaged packaging, leakage/spillage, taped/opened packaging. For Packaging types, the most commonly reviewed are bottles and jars, tubes and sticks, boxes, and cartons. The highly reviewed Product categories were craft supplies, home goods, clothing, and accessories. Summarization ensures that the dashboard presents clear, actionable narratives. This feature empowers managers with the insights they need to make informed decisions and drive continuous improvement.*



ANALYSIS

This data-driven dashboard empowers managers to proactively address packaging deficiencies, reducing returns, enhancing customer satisfaction, and streamlining operations. Example: Identifying a link between leaking bottles and packaging type enables targeted redesign. The ability to drill down into clusters and review summaries supports continuous improvement and resource optimization.

DEPLOYMENT

For deployment, bundle the trained model, CSV and HTML reports, dashboard app (Streamlit), and requirements.txt in a single GitHub repository. This enables managers to access key metrics and actionable insights with minimal friction.

Summary:

This approach delivers targeted, actionable insights from raw review data, driving business improvements that extend beyond the product itself.