

Product Line Profitability and Margin Performance Analysis for Nassau Candy Distributor: A Data-Driven Approach Using Exploratory Data Analysis and Interactive Dashboard

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Abstract

This paper presents a comprehensive data-driven profitability and margin performance analysis conducted on transactional sales data from Nassau Candy Distributor, a multi-product confectionery distribution company operating across four geographic regions in the United States. The dataset comprises 10,194 order records across 15 product lines grouped into three divisions — Chocolate, Sugar, and Other — spanning a two-year period from 3 January 2024 to 31 December 2025. Using Python-based exploratory data analysis (EDA) and an interactive Streamlit dashboard, this study identifies key profitability drivers, margin risks, cost structure inefficiencies, and product portfolio concentration vulnerabilities. Key findings reveal that the Chocolate division dominates revenue at 92.88% share with a 67.45% average gross margin, while the Sugar division — despite containing 7 of 15 products — contributes only 0.30% of total revenue. Pareto analysis confirms that 5 of 15 products generate 80% of total revenue, representing a significant concentration risk. The study also flags Kazookles as a high-cost-ratio product with a 7.69% gross margin and high sales and order volume, warranting immediate supplier cost renegotiation to restore margin to a sustainable level. Results are presented through an interactive five-module Streamlit dashboard offering real-time filtering by division, date, margin threshold, and product. This analysis provides actionable recommendations for product portfolio rationalization, cost renegotiation, and strategic pricing decisions.

Keywords: Gross Margin Analysis, Product Line Profitability, Pareto Analysis, Cost Structure Diagnostics, Exploratory Data Analysis, Streamlit Dashboard, Nassau Candy Distributor, Confectionery Distribution, Data Analytics, Business Intelligence

1. Introduction

In the highly competitive confectionery distribution industry, sales volume alone is an insufficient indicator of business health. A product may generate high order counts while simultaneously eroding

overall portfolio margins due to elevated manufacturing costs or unfavourable pricing structures. Nassau Candy Distributor, a multi-region US-based distributor handling 15 distinct product lines across three product divisions — Chocolate, Sugar, and Other — faces precisely this challenge. Without granular insight into per-product and per-division profitability, pricing and promotional decisions remain reactive and intuition-based rather than data-driven.

This research addresses that gap by applying structured exploratory data analysis (EDA) and interactive visualisation techniques to a dataset of 10,194 transaction records. The study is motivated by the core analytical questions: Which products truly drive gross profit? Where does the cost structure create margin risk? Which divisions underperform financially relative to their revenue share? And what portfolio-level concentration risks exist that could threaten financial stability if key products underperform?

The deliverable of this project is two-fold: a research paper documenting the analytical methodology and findings, and a five-module interactive Streamlit web application enabling non-technical stakeholders to explore profitability metrics through intuitive filters and real-time charts. The practical significance of this work lies in its direct applicability to product rationalisation, supplier cost renegotiation, and targeted promotional strategy.

2. Literature Review

Gross margin analysis has long been recognised as a fundamental tool in retail and distribution management. Kaplan and Norton (1996) established that financial performance metrics — including gross margin percentage and profit per unit — are essential leading indicators of sustainable business value. In the context of product portfolio management, Lambert and Cooper (2000) demonstrated that distributor profitability is disproportionately concentrated in a small subset of products, consistent with the Pareto Principle first articulated by Vilfredo Pareto in 1896.

The application of exploratory data analysis (EDA) for business decision-making was popularised by Tukey (1977), whose foundational work stressed the importance of visual pattern detection prior to formal statistical modelling. More recently, Chen et al. (2016) showed that interactive dashboards built on real transactional data provide materially better strategic outcomes than static reports, as they allow decision-makers to explore data dynamically and contextually.

In the food and confectionery distribution sector specifically, Bonanno (2003) found that product-level margin heterogeneity is a persistent structural characteristic — high-volume products frequently exhibit compressed margins due to competitive pricing pressure, while niche or premium products carry higher margins but lower absolute profit contribution. This tension between volume and margin is central to the Nassau Candy dataset and motivates the product categorisation framework employed in this study.

The use of Streamlit as a rapid prototyping framework for data science dashboards is well documented in recent literature. Developers and analysts have adopted it for its ability to convert Python EDA scripts into shareable, interactive applications without requiring front-end engineering expertise (Streamlit Inc., 2020). This study extends that tradition by delivering a production-grade dashboard that operationalises the EDA findings into five analytically distinct modules accessible to non-technical stakeholders.

3. Dataset Description and Analytical Methodology

3.1 Dataset Overview

The primary dataset is the Nassau Candy Distributor transactional sales file, comprising 10,194 order-level records covering the period 3 January 2024 to 31 December 2025 — a two-year observation window spanning 729 days. The dataset includes 18 fields covering order identification, logistics, customer geography, product classification, and financial metrics. Table 1 describes the key fields used in this analysis.

Table 1: Key Dataset Fields and Descriptions

Field	Type	Description
Order Date / Ship Date	Date	Order and shipment timestamps
Division	Categorical	Product group: Chocolate, Sugar, Other
Product Name	Categorical	15 distinct confectionery products
Region	Categorical	Interior, Atlantic, Gulf, Pacific
Ship Mode	Categorical	Standard, First, Second, Same Day
Sales (\$)	Numeric	Total revenue per order line
Cost (\$)	Numeric	Manufacturing/sourcing cost per line
Gross Profit (\$)	Numeric	Sales minus Cost
Units	Numeric	Quantity of product ordered

3.2 Data Cleaning and Validation

Prior to analysis, the following data quality operations were applied using pandas in Python:

- Records with zero or negative Sales values were excluded (validation confirmed no records required removal — all 10,194 rows had valid positive Sales)
- Records with zero or negative Cost values were excluded to prevent division errors
- Rows with missing values in Sales, Gross Profit, or Cost were dropped
- Units field: missing values were imputed as 1 and zero-unit records replaced with 1 to enable per-unit calculations
- Text fields (Product Name, Division, Region, Ship Mode) were stripped of whitespace and title-cased for consistency
- Date fields (Order Date, Ship Date) were parsed using pandas to `_datetime` with `dayfirst=True` format

Post-cleaning, the dataset retained all 10,194 records with no missing values, confirming high data quality. Three derived metrics were computed for each record: Gross Margin % ($\text{Gross Profit} / \text{Sales} \times 100$), Profit Per Unit ($\text{Gross Profit} / \text{Units}$), and Cost Ratio ($\text{Cost} / \text{Sales} \times 100$). Temporal aggregations were added at Month, Quarter, and Year granularity.

3.3 Profitability Metric Framework

The following Key Performance Indicators (KPIs) were defined as the primary analytical constructs throughout this study:

Table 2: Key Performance Indicators and Formulae

KPI	Formula	Purpose
Gross Margin %	$\text{Gross Profit} / \text{Sales} \times 100$	Core profitability ratio per product/division
Profit Per Unit	$\text{Gross Profit} / \text{Units}$	Margin efficiency per unit sold
Revenue Contribution	$\text{Product Sales} / \text{Total Sales}$	Portfolio revenue share
Profit Contribution	$\text{Product Profit} / \text{Total Profit}$	Portfolio profit share
Cost Ratio	$\text{Cost} / \text{Sales} \times 100$	Cost absorption relative to revenue
Margin Volatility	$\text{Max monthly margin} - \text{Min monthly margin}$	Temporal margin stability

3.4 Product Classification Framework

Products were classified into four strategic quadrants based on two dimensions: Total Sales (above or below portfolio median) and Average Gross Margin (above or below the healthy threshold). The healthy threshold was defined as the mean average gross margin across all products; the warning threshold as mean minus one standard deviation; and the risk threshold as mean minus two standard deviations. This yielded four categories:

- High Sales / High Margin — Core revenue and profit drivers; action: Maintain
- High Sales / Low Margin — Volume contributors with compressed margins; action: Reprice or Monitor
- Low Sales / High Margin — Efficient but underexposed products; action: Promote
- Low Sales / Low Margin — Portfolio liabilities; action: Discontinue or Renegotiate Cost

3.5 Analytical Modules

The analysis was structured into five sequential modules, mirroring the Streamlit dashboard architecture: (1) Executive Overview — portfolio-level KPIs and division summaries; (2) Product Profitability — product-level leaderboard and margin analysis; (3) Division Performance — comparative division efficiency analysis; (4) Profit Concentration (Pareto) — 80/20 rule applied to products and geographies; (5) Cost vs Margin Diagnostics — cost structure health and strategic intervention flags.

4. Exploratory Data Analysis and Findings

4.1 Portfolio-Level Executive Summary

At the aggregate portfolio level, Nassau Candy Distributor generated total revenue of \$141,783.63 against a gross profit of \$93,442.80 across the two-year study period (3 January 2024 – 31 December 2025), yielding an overall gross margin of 65.91%. This headline figure is broadly healthy relative to confectionery distribution benchmarks. However, as subsequent analysis reveals, this aggregate conceals significant heterogeneity across divisions and products.

Table 3: Portfolio-Level KPI Summary

Metric	Value	Interpretation
Total Revenue	\$141,783.63	Jan 2024 – Dec 2025 (2 years)
Total Gross Profit	\$93,442.80	Revenue minus Cost
Overall Gross Margin	65.91%	Healthy; benchmark-consistent
Total Order Records	10,194	Post-cleaning, all valid
Total Products	15	Across 3 divisions
Mean Order Value	\$13.91	Mean > Median — mild right skew
Median Order Value	\$10.80	Typical transaction size
Geographic Regions	4	Interior, Atlantic, Gulf, Pacific

The mean-to-median order value ratio of 1.29x indicates a modestly right-skewed sales distribution, driven by a minority of large-volume Chocolate bulk orders elevating the mean above the typical transaction size. This skew, while not extreme, signals that median order value (\$10.80) is the more representative central tendency for operational benchmarking.

4.2 Division-Level Performance Analysis

Division-level aggregation reveals a strongly asymmetric revenue and profit distribution. Table 4 presents the full breakdown. The Chocolate division dominates all financial dimensions, generating \$131,692.90 in revenue (92.88% portfolio share) at a 67.45% gross margin — the highest margin of the three divisions. The Other division contributes 6.82% of revenue at a significantly lower 44.84% margin, while Sugar — despite housing 7 of the 15 products — generates a negligible 0.30% revenue share.

Table 4: Division-Level Revenue and Profitability Breakdown

Division	Revenue (\$)	Gross Profit (\$)	Margin %	Revenue Share %	Products	Orders
Chocolate	\$131,692.90	\$88,824.62	67.45%	92.88%	5	9,844
Other	\$9,663.25	\$4,333.45	44.84%	6.82%	3	310
Sugar	\$427.48	\$284.73	66.61%	0.30%	7	40
Total	\$141,783.63	\$93,442.80	65.91%	100%	15	10,194

A critical structural observation emerges from this data: the Sugar division's performance is counterintuitive. Its 7 products carry a 66.61% average gross margin — nearly matching Chocolate — yet generate only \$427.48 in annual revenue. This indicates that Sugar products are structurally profitable at the unit level but suffer from near-zero market penetration, possibly due to inadequate distribution reach, pricing barriers, or lack of promotional investment. The Other division's 44.84% margin is structurally below the portfolio average, with Kazookles — despite generating strong order volume of 96 transactions and \$1,205.75 in revenue — contributing a compressed 7.69% gross margin due to its high manufacturing cost ratio, signalling a cost renegotiation opportunity rather than a demand or sales problem.

4.3 Product-Level Profitability Analysis

Table 5 presents the full product-level profitability breakdown, ranked by Total Sales. The five Chocolate Wonka Bar variants collectively dominate both revenue and profit, with Wonka Bar – Nutty Crunch Surprise achieving the highest gross margin at 71.35%. Notably, Kazookles (Other division) records a 7.69% gross margin against 96 orders and \$1,205.75 in revenue — indicating that demand is healthy but manufacturing costs are structurally misaligned, placing it in the Renegotiate Cost action category rather than a sales or market failure zone.

Table 5: Complete Product-Level Profitability and Strategic Action Summary

Division	Product Name	Sales (\$)	Profit (\$)	Margin %	Orders	Action
Chocolate	Wonka Bar - Triple Dazzle Caramel	\$28,485.00	\$18,610.20	65.33%	2,015	Maintain
Chocolate	Wonka Bar - Scrumdiddlyumptious	\$27,874.80	\$19,357.50	69.44%	2,064	Maintain
Chocolate	Wonka Bar - Milk Chocolate	\$26,867.75	\$17,443.37	64.92%	2,137	Maintain
Chocolate	Wonka Bar - Fudge Mallows	\$24,890.40	\$16,593.60	66.67%	1,818	Maintain
Chocolate	Wonka Bar - Nutty Crunch Surprise	\$23,574.95	\$16,819.95	71.35%	1,810	Maintain
Other	Lickable Wallpaper	\$7,860.00	\$3,930.00	50.00%	94	Monitor
Other	Kazookles	\$1,205.75	\$92.75	7.69%	96	Renegotiate Cost
Other	Wonka Gum	\$597.50	\$310.70	52.00%	120	Monitor
Sugar	Everlasting Gobstopper	\$130.00	\$104.00	80.00%	3	Promote
Sugar	Fizzy Lifting Drinks	\$78.75	\$47.25	60.00%	6	Promote
Sugar	Hair Toffee	\$76.50	\$59.50	77.78%	4	Promote
Sugar	SweeTARTS	\$61.50	\$28.70	46.67%	10	Discontinue

Division	Product Name	Sales (\$)	Profit (\$)	Margin %	Orders	Action
Sugar	Laffy Taffy	\$53.73	\$33.48	62.31%	10	Promote
Sugar	Nerds	\$15.00	\$7.00	46.67%	4	Discontinue
Sugar	Fun Dip	\$12.00	\$4.80	40.00%	3	Discontinue

4.4 Pareto (80/20) Concentration Analysis

Pareto analysis reveals that 5 of 15 products (33% of the product catalogue) generate approximately 80% of total portfolio revenue — all five being Wonka Bar Chocolate variants. This extreme concentration creates a structural over-dependency risk: any disruption to Chocolate supply, pricing, or consumer demand would materially impact the entire portfolio. An identical pattern holds for profit concentration — the same 5 products contribute approximately 80% of gross profit.

Table 6: Pareto Concentration Summary

Concentration Metric	Value	Implication
Products generating 80% of Revenue	5 of 15 (33%)	Extreme top-heavy concentration
Products generating 80% of Profit	5 of 15 (33%)	Profit mirrors revenue — no diversification
Division generating 93% of Revenue	Chocolate only	Single-division dependency
Top product's revenue share	~20% (Triple Dazzle Caramel)	Individual product risk
Bottom 10 products' combined revenue	\$10,090.73 (7.12%)	Negligible contribution from 67% of products

Regional Pareto analysis reveals a more balanced geographic distribution: the Pacific region leads with \$46,301.53 in revenue (32.66%), followed by Atlantic (\$41,197.24, 29.06%), Interior (\$32,037.60, 22.60%), and Gulf (\$22,247.26, 15.69%). Gross margins are consistent across all four regions (65.47%–66.43%). However, revenue distribution is uneven — Pacific and Atlantic together account for 61.7% of total revenue, while Gulf contributes only 15.69%, warranting a separate review of Gulf's market penetration.

Table 7: Regional Revenue and Margin Breakdown

Region	Revenue (\$)	Gross Profit (\$)	Gross Margin %	Revenue Share %
Pacific	\$46,301.53	\$30,485.94	65.84%	32.66%
Atlantic	\$41,197.24	\$26,973.70	65.47%	29.06%
Interior	\$32,037.60	\$21,282.49	66.43%	22.60%
Gulf	\$22,247.26	\$14,700.67	66.08%	15.69%

4.5 Cost Structure Diagnostics

The cost vs margin diagnostic module identifies three distinct product groups based on cost ratio and gross margin performance. Products in the first group — all five Chocolate Wonka Bars — maintain cost ratios between 28.65% and 35.08% with healthy gross margins above 64%, representing well-managed cost structures. The second group — Lickable Wallpaper and Wonka Gum (Other division) — carries cost ratios of 50% and 48% respectively, with margins that sit in the monitor zone, suggesting scope for cost renegotiation or modest price increases.

The most important diagnostic finding concerns Kazookles: with a cost ratio of 92.31% (cost absorbs \$0.923 of every dollar of revenue), its 7.69% gross margin falls well below the portfolio mean. However, critically, Kazookles records both high sales (\$1,205.75, above the portfolio product median) and high order volume (96 orders, above the median), which means the dashboard correctly assigns it a Renegotiate Cost action — not discontinuation. The product has genuine, sustained customer demand; the issue is entirely a cost structure problem with the manufacturing supplier, and it should be treated as a supplier negotiation priority rather than a portfolio liability.

The Sugar division products present a distinctive diagnostic profile: high gross margins (40%–80%) but near-zero absolute revenue. This is not a cost structure problem — it is a distribution and demand generation problem. Products such as Everlasting Gobstopper (80% margin) and Hair Toffee (77.78% margin) are structurally profitable and represent high-value promotional opportunities if marketing and distribution investment can be directed toward them.

5. Streamlit Interactive Dashboard

5.1 Architecture Overview

The analytical findings from the EDA were operationalised into a five-module Streamlit web application. The application loads and pre-processes data using cached functions to ensure sub-second response times for interactive filtering. The sidebar provides four cross-cutting filters — Division selector, Date Range picker, Gross Margin % slider, and a multi-select Product filter — that propagate across all dashboard modules simultaneously.

Table 8: Streamlit Dashboard Module Architecture

Module	Page	Key Visualisations / Features
Executive Overview	p1_overview.py	6 KPI cards (Gross Margin %, Profit per Unit, Revenue Contribution, Profit Contribution, Margin Volatility, Critical Zone); Sales Distribution histogram (Mean vs Median); Division Performance charts (3 selectable views: Revenue/Profit/Margin, Revenue vs Gross Profit, Cost vs Profit Split); Revenue & Profit Pareto by product; KDE Gross Margin % distribution by division; Product Margin Summary Table with action flags and colour gradient; 4 strategic

Module	Page	Key Visualisations / Features
		assessment cards (Portfolio Health, Division Concentration Risk, Sales Distribution, Core Portfolio)
Product Profitability	p2_product.py	Gross Margin % leaderboard (all products ranked); Profit per Unit bar chart; Total Profit Contribution bar chart; Product Quadrant Analysis — Sales vs Margin scatter (4-quadrant: High/Low Sales × High/Low Margin); Product Margin Leaderboard table; Product Portfolio Assessment cards
Division Performance	p3_division.py	Revenue vs Gross Profit by Division (grouped bars); Gross Margin % Distribution by division; Revenue Share vs Profit Share comparison; Average Gross Margin % by Division bar chart; Division Summary Table; Financial Efficiency & Structural Margin Assessment cards
Profit Concentration	p4_pareto.py	Revenue Pareto by Product; Profit Pareto by Product; Revenue Pareto by Region; Profit Pareto by Region; Revenue Pareto by State; Profit Pareto by State; Order Concentration by State (all states); Order Concentration by Province — Canada; Order Concentration Top 20 States; State Over-Dependency Risk Table
Cost Diagnostics	p5_diagnostics.py	Cost vs Sales scatter (Margin Positioning); Cost vs Gross Profit chart; Cost Ratio by Product bar chart; Margin Volatility Over Time by Division (average & std deviation); Action Recommendations breakdown; Strategic Assessment cards with intervention flags

5.2 Technology Stack

- Python 3.11+ — Core analytical and application language
- Streamlit \geq 1.32.0 — Web application framework and interactive dashboard engine
- Pandas \geq 2.0.0 — Data loading, cleaning, and aggregation
- Plotly \geq 5.18.0 — Interactive chart rendering (bar, scatter, histogram, KDE)
- SciPy \geq 1.11.0 — Gaussian KDE computation for margin distribution visualisation
- Matplotlib \geq 3.8.0 — Colour map generation for margin gradient styling
- NumPy — Supporting numerical operations and threshold calculations

The dashboard implements session-state-based filter management with reset buttons for each filter dimension, ensuring users can easily return to full-portfolio views without manual deselection. A product checkbox panel with a scrollable container enables multi-product selection without cluttering the sidebar. All charts use consistent colour coding: Chocolate (#7B4F2E), Sugar (#E8963A), and Other (#6C63FF) divisions.

6. Discussion

The findings from this analysis converge on three overarching strategic conclusions for Nassau Candy Distributor.

First, the portfolio's financial health is deceptively strong at the aggregate level but structurally fragile at the division level. The 65.91% portfolio margin is anchored entirely by Chocolate's 92.88% revenue dominance. If the Chocolate division experienced a 10% margin compression — not an unlikely scenario given supply chain volatility or competitive pricing pressure — the overall portfolio margin would fall to approximately 59%, a materially significant deterioration. Diversification of the high-margin product base beyond Chocolate is therefore a strategic priority.

Second, the Sugar division represents a significant untapped value opportunity. The division's average margin of 66.61% — nearly matching Chocolate's 67.45% — combined with near-zero revenue (\$427.48) suggests that the barrier to Sugar performance is not product quality or cost structure but rather distribution scale and market presence. Strategic investment in Sugar product promotion, particularly for Everlasting Gobstopper (80% margin) and Hair Toffee (77.78% margin), could meaningfully expand the high-margin product tier without requiring new product development.

Third, Kazookles represents a cost renegotiation priority, not a failing product. At 7.69% gross margin and a 92.31% cost ratio, the product's profitability is severely compressed — but its 96 orders and \$1,205.75 in revenue place it above the portfolio median on both sales and order volume dimensions. The dashboard correctly classifies it as Renegotiate Cost: the product has demonstrated market demand; the problem lies entirely with the manufacturing costs. A targeted cost renegotiation targeting a reduction from \$3.00/unit to approximately \$2.25/unit could restore the gross margin to above 30%, transforming this product from a margin liability into a viable contributor.

7. Recommendations

Based on the foregoing analysis, the following data-driven recommendations are made:

- **Immediate Kazookles Cost Renegotiation:** Conduct a competitive pricing analysis and renegotiate manufacturing costs. Target a minimum gross margin of 30%. If unachievable within two quarters, initiate controlled discontinuation.
- **Sugar Division Activation Campaign:** Allocate targeted promotional budget to Everlasting Gobstopper, Hair Toffee, and Laffy Taffy — the three highest-margin Sugar products. Expand distribution channels and track monthly order volume uplift against a 100% revenue growth target within two quarters.
- **Chocolate Dependency Risk Mitigation:** Develop a medium-term product roadmap to increase the revenue contribution of the Other and Sugar divisions to a combined minimum of 15% within 18 months, reducing the single-division dependency below 85%.
- **Lickable Wallpaper and Wonka Gum Monitoring:** Both products generate reasonable order volumes (94 and 120 respectively) at 50% and 52% margins. While not in crisis, they sit below the portfolio average and should be reviewed for modest price increases of 5%–8% in the next pricing cycle.

- **Regional Strategy Consistency:** Margins are consistent across all four regions (65.47%–66.43%), indicating no regional pricing inefficiency. However, the Gulf region's 15.69% revenue share versus Pacific's 32.66% suggests untapped Gulf demand — particularly for Chocolate products — that targeted distribution or logistics investment could address.
- **Dashboard Integration into Monthly Operations:** The Streamlit dashboard should be embedded into the monthly management reporting cycle, with the Cost vs Margin Diagnostics module reviewed at each product portfolio meeting to catch emerging margin erosion before it becomes critical.

8. Conclusion

This study moved beyond surface-level revenue reporting to expose the structural dynamics of Nassau Candy's product portfolio — identifying which products sustain the business, which divisions carry hidden inefficiencies, and where the cost architecture is misaligned with pricing. The findings reveal a portfolio that is financially healthy but strategically fragile: over-reliant on a single division, sitting on an underutilised high-margin Sugar segment, and carrying at least one product whose margin problem is cost-driven rather than demand-driven.

The Streamlit dashboard ensures these findings remain actionable beyond this report — making profitability intelligence continuously accessible to decision-makers as the business evolves. Future research could extend this work through time-series margin forecasting, customer-level profitability segmentation, and factory-level cost benchmarking using the product-factory correlation data available in the project documentation.

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