Maximising Profitability: A Multi-headed approach for enabling Multi-Channel sales and Inventory Optimisation for T.R Departmental

A Final report for the BDM capstone Project

Submitted by

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Executive summary

Executive Summary

Problem Statement: The business faced challenges in maximizing profit and optimizing inventory due to a lack of structured data analysis. The absence of clear insights into sales trends, customer contributions, and product profitability led to inefficiencies in decision-making. This study aimed to analyze sales data to identify key revenue drivers, assess customer impact on profitability, and categorize products based on their financial contribution to the business.

Data Collection and Processing: Sales data was extracted from the business's recording software in the form of monthly Excel files. These files were consolidated using Python to create a unified dataset. Data cleaning was performed by removing irrelevant columns and correcting inconsistencies. The owner confirmed that negative quantity entries were erroneous, as refunds do not occur. Corrections were made to ensure accurate calculations of revenue and profit.

Feature Engineering and Analysis: Key financial metrics such as revenue, profit, and profit margin were computed. Profit margins were categorized into **High Margin, Medium Margin, and LowMargin** groups to assess product performance.

Customer Contribution to Revenue: A customer-based revenue analysis identified the top-paying customers and calculated their contribution to total revenue. The percentage contribution of each customer was determined, and visualizations such as bar and pie charts were used to illustrate their impact on the business's financial health.

Statistical Analysis (Daily, Weekly, Monthly): Sales data was analyzed across different timeframes to identify revenue trends and seasonality. Daily, weekly, and monthly revenue and profit trends were computed, revealing peak sales periods and potential low-demand phases. These insights helped in recognizing patterns that could be used for forecasting and strategic planning.

Product Analysis: A detailed evaluation of product performance was conducted by analyzing revenue and profit per item. Products were ranked based on their profitability and contribution to overall sales. The classification of products into different profit margin categories allowed for better inventory and pricing strategies.

Key Findings and Business Implications:

1. **Top-paying customers** contribute a significant portion of revenue, highlighting the need for targeted customer retention strategies.
2. **Seasonal and weekly trends** indicate fluctuations in sales, enabling better stock planning and marketing efforts.
3. **Profitability analysis** reveals that while some products drive high revenue, others generate minimal or negative profit, suggesting the need for pricing adjustments or inventory restructuring.

This study provided data-driven insights that can guide decision-making to improve profitability and streamline inventory management.

Detailed explanation of analysis methods

Procurement of data:

The data was extracted from the business's recording software in the form of individual Excel files, each representing a different month. These files were then combined usinga simple Python function to merge them into a single, comprehensive dataset.

During the data cleaning process, unnecessary columns were identified and removed, particularly those that were blank due to formatting issues, such as new date markers in each monthly file. Since the InvoiceDate column already contained the necessary date information, these redundant columns were dropped.

Additionally, the dataset contained negative quantity sold values, which initially suggested refunds. However, after consulting with the business owner, it was confirmed that refunds never occur in their operations. As a result, all negative quantity entries were treated as erroneous and corrected. Moreover, any columns that were dependent on the quantity column, including total amount and profit calculations, were recalculated to ensure consistency and accuracy.

Extraction of useful features

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	CustomerName	ItemName	InvoiceDate	MOP	Qty	CurrStock	MRP	Purchase Rate	SRate	Amount	TaxPer	TaxAmt	NetAmt	Profit
2	CASH CUSTOMER	SUGAR 1 KG	01-09-2024	Cash	1	42	55	39.05	52.38	52.38	5	2.62	55	13.33
3	CASH CUSTOMER	SUGAR 1 KG	01-09-2024	Cash	1	42	55	39.05	52.38	52.38	5	2.62	55	13.33
4	CASH CUSTOMER	SUGAR 1 KG	01-09-2024	Cash	1	42	55	39.05	52.38	52.38	5	2.62	55	13.33
5	CASH CUSTOMER	AMULYA DAIRY 200GM	01-09-2024	Cash	1	3	95	77.22	90.48	90.48	5	4.52	95	13.26
6	CASH CUSTOMER	INDIA GATE ROZZANA 1KG	01-09-2024	Card	1	11	122	70	116.19	116.19	5	5.81	122	46.19
7	5C	INDIA GATE DUBAR BASMATI RICE 1KG	01-09-2024	Cash	1	20	167	120	159.05	159.05	5	7.95	167	39.05
8	CASH CUSTOMER	SENSODYNE FRESH MINT 40GM	01-09-2024	Cash	1	1	90	58.95	76.27	76.27	18	13.73	90	17.32
9	CASH CUSTOMER	ANNAPURNA GHEE 50ML	01-09-2024	Card	1	17	46	34.91	41.07	41.07	12	4.93	46	6.16
10	CASH CUSTOMER	TATA SALT 1KG	01-09-2024	Cash	1	43	30	25	30	30	0	0	30	5
11	CASH CUSTOMER	TATA SALT 1KG	01-09-2024	Card	1	43	30	25	30	30	0	0	30	5
12	CASH CUSTOMER	TATA SALT 1KG	01-09-2024	Cash	1	43	30	25	30	30	0	0	30	5
13	CASH CUSTOMER	TATA SALT 1KG	01-09-2024	Cash	1	43	30	25	30	30	0	0	30	5

Figure 1: Cleaned Data

To ensure a streamlined and meaningful analysis, a careful selection of relevant features was performed. Columns that did not contribute to the overall insights were identified and removed through manual inspection. Specifically, attributes such as 'S.No', 'Date', 'Code', 'InvoiceNo', 'Batch', 'Series', 'Design No', 'Field2', 'Field3', 'Field4', and 'Disc' were eliminated, as they either contained redundant information or had no impact on the profit and sales analysis.

By removing these columns, the dataset was optimized for better performance and accuracy, allowing the focus to remain on key indicators such as quantity sold, selling price, purchase rate, net profit, and profit margins.

Use of Pandas, Excel

In this analysis, **Pandas** was utilized to process and analyze the dataset efficiently. Through Pandas, sales and profit data were aggregated, items were categorized based on their profit margins, and key trends were identified, such as the contribution of high-margin, medium-margin, and low/negative-margin items. Functions like `groupby()`, `sum()`, and `merge()` were employed to segment and compute profits across different item categories. Additionally, Pandas was used to filter out specific customers, rank the top contributors, and calculate their percentage contribution to the total profit.

To further refine the analysis, the processed data was exported to **Excel**, where pivot tables and charts were created to compare sales quantities and profit margins across different categories. Excel's visualization tools, including clustered bar charts and percentage contribution analysis, provided a clearer interpretation of the results. The integration of **Pandas for data processing** and **Excel for visualization** facilitated a comprehensive approach to understanding sales performance and profitability distribution.

Calculation of revenue, profit, profit margin

In the midterm report, there was a presentation error which led to misinterpretation. It has been thus corrected and hence, Amount is the column of interest

$$Profit = Amount - (Purchase\ Rate\ \times Qty)$$

$$Profit\ Margin = \frac{Profit}{Amount} \times 100$$

Customer contribution to revenue

Customer contribution to revenue was analyzed to determine which customers were responsible for the largest share of total sales. This involved:

- Summing up the **total profit** generated by each customer.
- Identifying **top customers** based on their contribution to total revenue/profit.
- Comparing individual customer revenue to **total revenue** to calculate their percentage contribution:

$$Customer\ contribution = \frac{Customer\ Revenue}{Total\ Revenue} \times 100$$

- Visualizing customer contributions using **bar charts and pie charts** for better insight into revenue distribution.

Statistical Analysis

A detailed statistical analysis was performed on sales trends at different time intervals to understand seasonality and patterns in revenue generation.

- **Daily Analysis**:
  - Grouped sales data by **InvoiceDate** to calculate daily revenue and profit trends.
  - Identified peak sales days and slow business days.

- **Weekly Analysis**:
  - Converted **InvoiceDate** into **weekly periods** using pandas and aggregated revenue, profit, and sales quantities per week.
  - Analyzed fluctuations in weekly revenue to identify recurring trends.

- **Monthly Analysis**:
  - Grouped data by **Month** to compute total revenue, profit, and sales.
  - Compared month-over-month growth and decline to spot seasonal patterns.

The insights from these analyses were visualized using **line charts and bar graphs** to highlight revenue fluctuations.

Product Analysis of Revenue, Profit, etc

A detailed **product-wise** analysis was conducted to evaluate which items contributed the most to revenue and profit.

- **Revenue Contribution**:
  - Calculated total revenue per **ItemName**.
  - Ranked products based on revenue contribution to identify top-selling items.
- **Profitability Analysis**:
  - Computed **total profit per product** to identify the most profitable items.
  - Analyzed **profit margin** per product to assess which items had the highest and lowest profitability.
- **Product Categories**:
  - Products were categorized into **High Revenue, High Profit**, and **Low Revenue, Low Profit** groups.
  - This allowed identification of **best-selling vs. low-performing products**.

The findings were presented using **bar charts, scatter plots, and distribution graphs** to highlight trends in product performance.

Results and findings

Financial Insights & Performance Analysis:

The analysis of revenue, profit, and sales trends provides key insights into the financial performance of the business. The findings from both statistical summaries and visual trends align to highlight critical aspects of sales variability, profitability, and revenue distribution.

	Metric	Value
0	Average Daily Sales	24403.6
1	Standard Deviation	5732.58
2	Minimum Sales	11766
3	Maximum Sales	46988.4
4	Median Sales	23509.7

Figure 2: Daily Statistics

Daily average sales statistic

- The average daily sales stand at ₹24,403.6, providing a baseline for expected revenue generation per day.
- A high standard deviation of ₹5,732.58 indicates significant fluctuations in daily sales, suggesting inconsistent demand patterns.
- The minimum recorded sales in a day (₹11,766) contrast sharply with the maximum (₹46,988.4), further reinforcing the variability in daily revenue.
- The median daily sales (₹23,509.7) are slightly lower than the average, indicating a slightly left-skewed distribution, where some low-revenue days pull the average down.
- The gap between maximum and minimum daily sales suggests that external factors might be influencing sales performance.

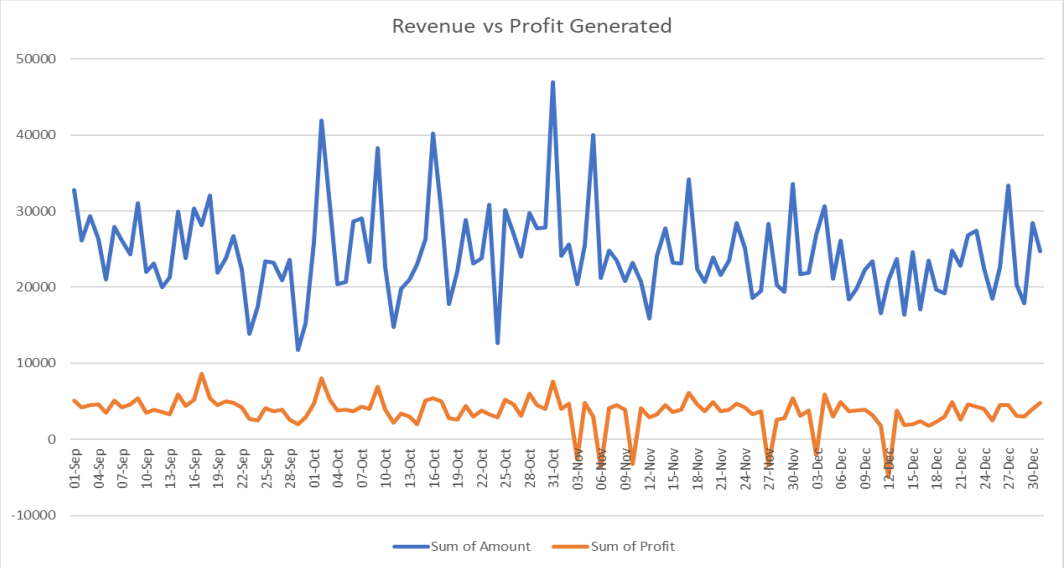

Figure 3: Time series analysis: Revenue vs Profit

- Certain dates, particularly around late October and early November, exhibit sharp spikes in revenue.
- The profit (orange line) follows a similar trend but with lower magnitude.
- Despite revenue fluctuations, profit remains relatively stable, with some sharp dips observed.
- Around early November, there are instances where profit drops sharply and even touches zero or negative values.
- This suggests that either heavy discounts, high purchase costs, or operational inefficiencies could be affecting profitability.
- Even though revenue fluctuates significantly, profit remains within a much narrower range, indicating a relatively stable profit margin percentage.
- However, periods of low revenue do not necessarily correspond to higher profit margins, which suggests external factors influencing profitability.

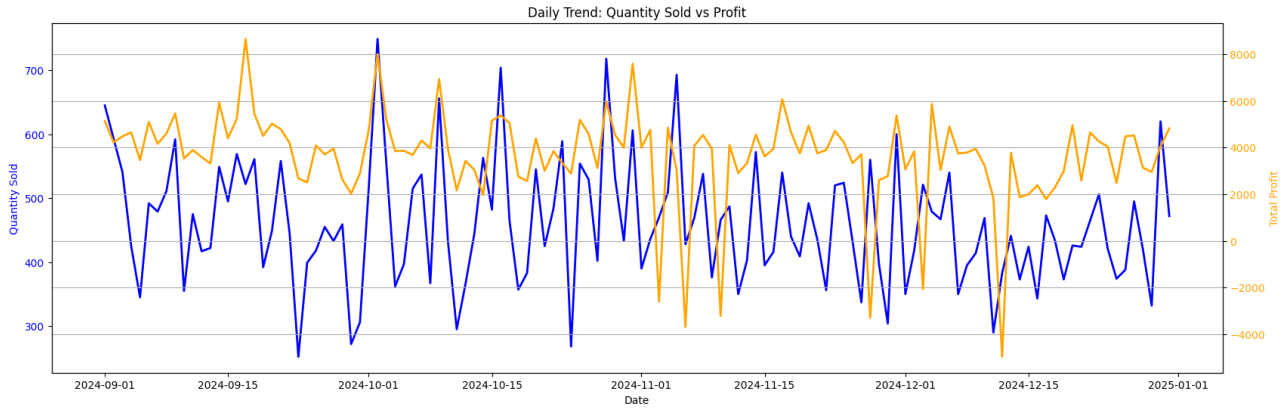

Figure 4: Correlation between Qty sold vs Profit

- The correlation score of -0.0104 between the quantity of items sold and profit suggests an extremely weak negative relationship between these two variables. This means that selling more items does not significantly impact profits, and in some cases, it may even slightly reduce them.
- Such a correlation indicates that higher sales volume does not necessarily translate to higher profitability.
- The presence of low-margin or discounted items contribute heavily to sales but not to profits.
- These may be attributed to low footfall due to seasonality change or festive changes.

CASH CUSTOMER	JOHNSONS BABY MILK SOAP 75GM	03-11-2024	Cash	1	1	68	51.45	57.63	57.63	18	10.37	68	6.18	10.72358147
CASH CUSTOMER	ORAL-B FRESH CLEAN NEEM TOOTH BRUSH 1N	03-11-2024	Card	1	6	25	20	21.19	21.19	18	3.81	25	1.19	5.615856536
CASH CUSTOMER	COLGATE STRONG TEETH 38G	03-11-2024	Card	1	40	20	15.33	16.95	16.95	18	3.05	20	1.62	9.557522124
CASH CUSTOMER	DHARA RSBO ILTR	03-11-2024	Cash	1	11	135	138	128.57	128.57	5	6.43	135	-9.43	-7.334525939
CASH CUSTOMER	RUCHI MACARONI 175GM	03-11-2024	Cash	1	7	20	14.88	17.86	17.86	12	2.14	20	2.98	16.68533035
CASH CUSTOMER	LIRIL LIME & TEA TREE OIL 75G	03-11-2024	Cash	1	26	26	20.4	22.03	22.03	18	3.97	26	1.63	7.399001362

Figure 5: An example of lower Selling Price

- As is evident from the above attachment, there are instances where SP falls below CP which lead to a loss.
- This leads to cumulative losses, which can have a significant impact on overall profitability if not managed effectively.
- During the first and second weeks of October, there was a noticeable decline in customer activity.
- This slowdown coincides with the Durga Puja festival, when many people travel or focus on celebrations rather than shopping.
- As a result, the business experienced a temporary downturn, requiring time to regain momentum.
- A further decline in sales can be observed in November and December.
- This trend is likely influenced by seasonal changes, including colder weather and reduced outdoor activities, which in turn reduces footfall

- Additionally, this period aligns with study leaves and exam preparations, causing fewer customers to visit, leading to lower sales and profit generation.

3.2 Contribution of Items

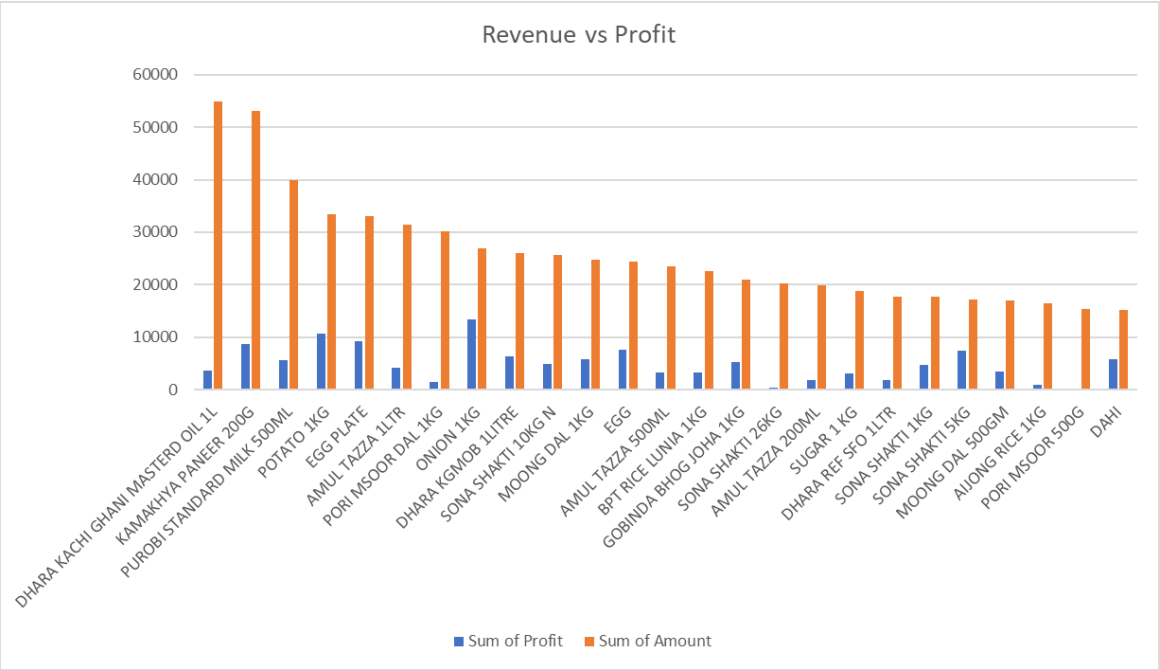

Figure 6: Graph of revenue vs Profit Generated

- This chart compares the revenue (orange bars) and profit (blue bars) for various items.
- Items such as Potato 1KG and Onion 1KG contribute significantly to profit.
- On the other hand, high-revenue items like Purabi Standard Milk 500ML and Dhara Kachi Ghani Masterd Oil 1L show relatively smaller profit contributions, suggesting low margins despite high sales volumes.
- Products like eggs and Amul Tazza (multiple variants) have an almost consistent revenue but limited profit contributions, reinforcing their role as staple items with competitive pricing.

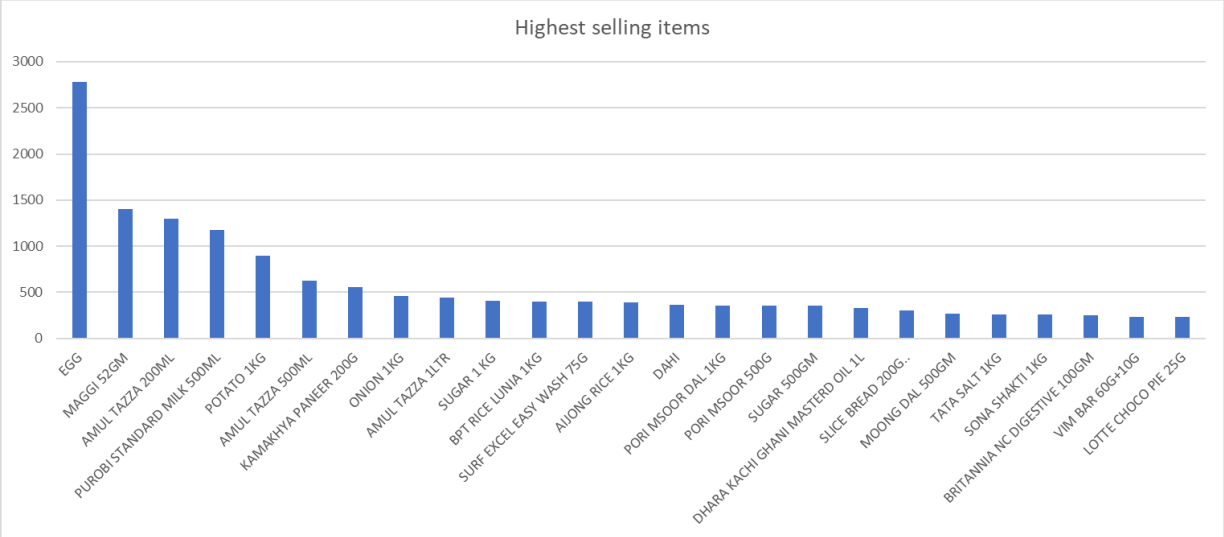

Figure 7: A graph of highest selling items

- This chart ranks products based on their sales volume.
- Eggs dominate as the highest-selling item, followed by Maggi 52 GM, Amul Tazza 200 ML, and Purabi Standard Milk 500ML.
- These items are essential daily-use products that drive high sales volumes but generally exhibit lower profit margins, as seen.
- Other staples like potatoes and onions are also among the highest-selling items.
- Specialty products such as Kamakhya Paneer 200G appear in this list but at a lower sales rank compared to staples.
- This reinforces the fact that the highest selling products are not always the highest profit generating.

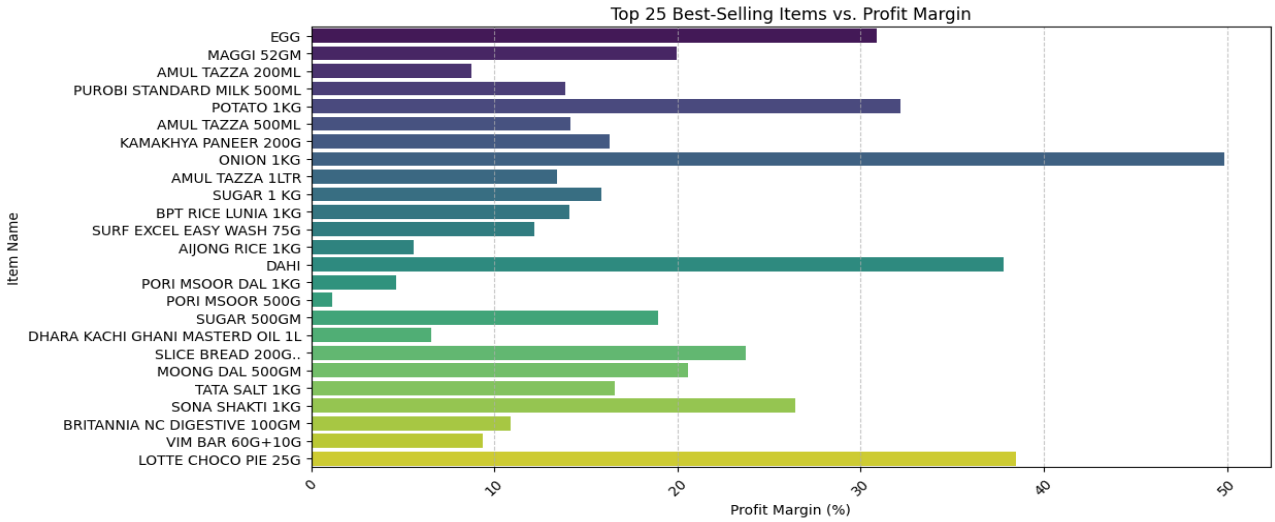

Figure 8: Profit margin for 25 best sellers

- **High-Selling Products with Low Profit Margins**

Several high-selling products, such as Eggs, Maggi 52GM, Amul Tazza 200ML, and Purabi Standard Milk 500ML, exhibit very low profit margins, generally below 10%. These items are likely staples or essential goods that are priced competitively to attract customers. Their low margins suggest that while they drive significant sales volume, their contribution to overall profitability is limited. This aligns with the strategy of using such products as loss leaders to increase foot traffic or customer retention.

- **Products with Moderate Profit Margins**
  Items like Sugar 1KG, Onion 1KG, and Potato 1KG have slightly higher profit margins compared to the lowest-margin items but still fall within the moderate range (10–20%). These are also staple products, but their slightly higher margins suggest some room for profitability while maintaining competitive pricing.
- **High-Margin Products**
  Products such as Kamakhya Paneer 200G, Britannia NC Digestive 100GM, and Vim Bar 60G+10G stand out for their significantly higher profit margins, exceeding 30% and, in some cases, reaching close to or above 40%. Among these, Kamakhya Paneer has the highest profit margin (approximately 50%), making it a key driver of profitability despite potentially lower sales volumes. These items are likely premium or niche products that cater to specific customer segments willing to pay a premium price.
- **Low-Selling but Profitable Items**
  Products like Lotte Choco Pie 25G and Britannia NC Digestive 100GM appear to have relatively lower sales volumes but high profit margins. These items may not contribute significantly to overall revenue due to limited demand but are valuable for their disproportionate impact on profits.

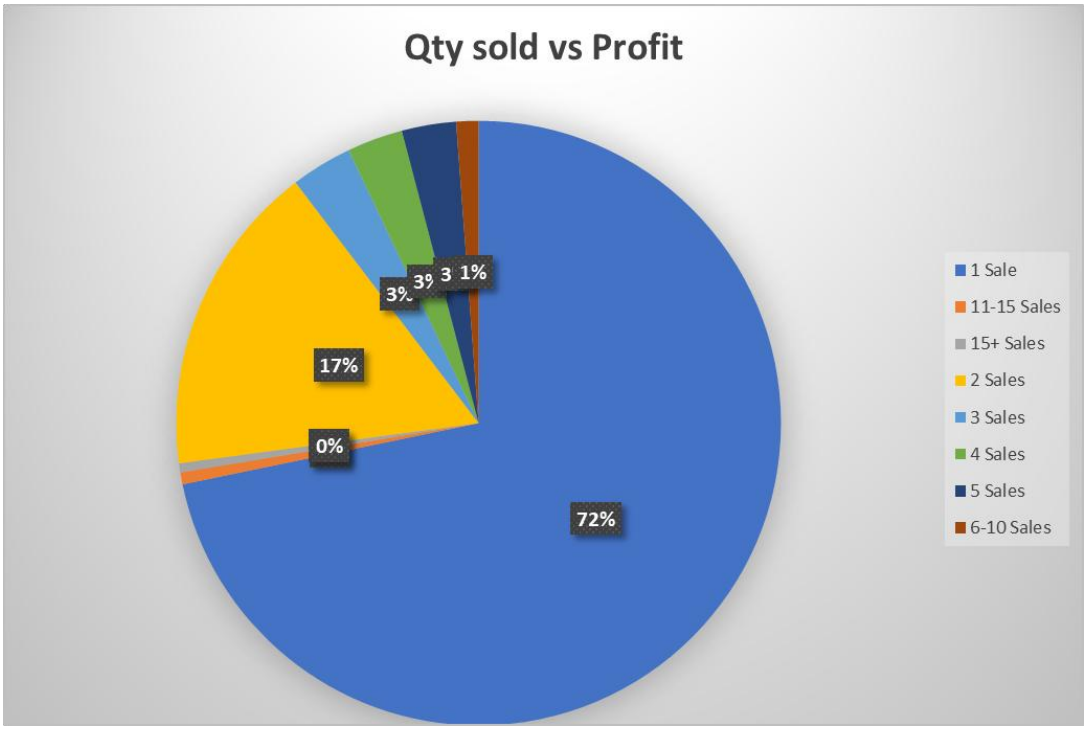

Figure 9: Quantity sold per sale vs profit

The pie chart titled "Qty Sold vs Profit" provides a detailed breakdown of how sales volume correlates with profit contribution. Here are the key insights:

- Dominance of Low-Selling Products (1 Sale)
  - 72% of total profits come from products sold only once.
  - This is a significant finding, as it highlights the importance of low-selling, high-margin products in driving overall profitability.
  - These products are likely niche or premium items such as Kamakhya Paneer 200G, Britannia NC Digestive 100GM, and Lotte Choco Pie 25G, which have high profit margins but limited demand.
  - The disproportionate profit contribution from these products suggests that their pricing strategy is highly effective, even if they do not sell in large quantities.

- Moderate-Selling Products (2–5 Sales)
  - Products sold in small quantities (2–5 sales) collectively contribute 17% of total profits.
  - These items likely include moderately priced goods with balanced demand and margins, such as Dhara Kachi Ghani Mastered Oil 1L, Moong Dal 500GM, and Slice Bread 200GM.
  - While their individual contributions are smaller compared to the low-selling, high-margin items, they represent a steady source of profitability.

- High-Selling Products (11+ Sales)
    - Surprisingly, products sold more than 15 times contribute 0% to total profits.
    - This indicates that high-selling staples like Eggs, Maggi 52GM, Amul Tazza (200ML, 500ML, 1L), and Purabi Standard Milk 500ML generate revenue but operate on razor-thin margins.
    - These items are priced competitively to attract customers and drive bulk sales but do not significantly impact profitability.

- Niche Categories (6–10 Sales
    - Products sold between 6–10 times contribute a small share of profits (approximately 3%).
    - These items might include specialty goods or mid-tier products that fall between staples and premium items in terms of pricing and demand.

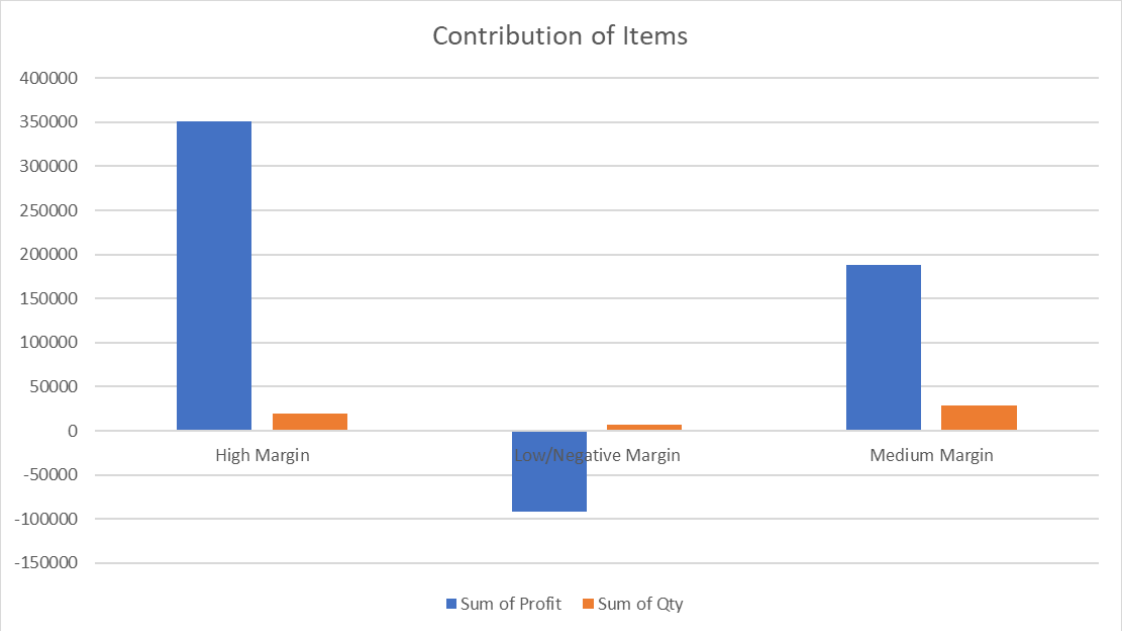

Figure 10: Item category vs profit margins

This bar chart categorizes items into three groups based on their profit margins: High Margin, Medium Margin, and Low/Negative Margin. It compares the total profit and quantity sold for each category, providing a clear picture of how different types of products contribute to overall business performance.

- High-Margin Products
    - High-margin items contribute the largest share of profits, totaling over ₹350,000, despite having a relatively low quantity sold.

- These products include premium or niche items such as Kamakhya Paneer 200G, Sona Shakti, Dahi, and Lotte Choco Pie 25G. These items are priced to yield significant profit per unit, even though their demand is limited.
- The disproportionate contribution of high-margin items to overall profitability underscores their importance in balancing the low profitability of staples and low-margin products.
- This category highlights the effectiveness of premium pricing strategies for specialized products that cater to specific customer segments.

- Medium-Margin Products
  - Medium-margin items contribute approximately ₹150,000 to total profits, with a moderate quantity sold.

  - These include moderately priced goods like Sugar, Moong Dal 500GM, and Slice Bread 200GM, which maintain a balance between demand and profitability.

  - The steady contribution from medium-margin products makes them a reliable source of revenue and profit. They act as stabilizers for the business by providing consistent returns without relying on extreme sales volumes or high margins.

- Low Margin Products
  - Low Margin items show a net loss in profit despite having a higher quantity sold compared to high-margin products. This category includes Poori Masoor Dal, Aijong Rice.

  - These staples are essential for driving customer traffic and generating revenue but operate on razor-thin margins or even losses. The losses in this category are primarily due very low selling price and due to the selling price (SP) being lower than the cost price (CP). This could be attributed to competitive pricing strategies or promotions aimed at attracting customers.

  - While these products are critical for maintaining customer loyalty and consistent sales, their negative impact on profitability highlights the need for cost optimization or pricing adjustments.

Analysis of customers

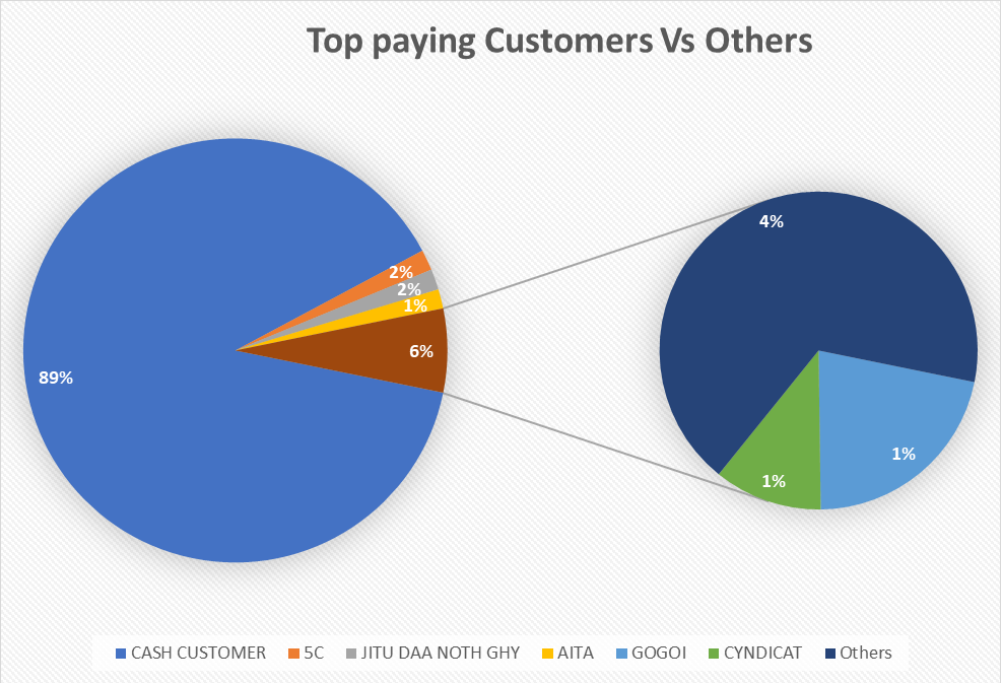

Figure 11: pie graph of top customers

- Cash customers contribute a staggering 89% of total profits (₹398,319.44). This indicates that most transactions are made by walk-in customers or those paying upfront in cash.
- This group is critical for maintaining overall profitability and likely represents a broad customer base.
- Among named customers, 5C contributes the highest profit (₹7,059.53), followed closely by Jitu Daa Noth GHY (₹7,036.76), AITA (₹6,572.70), and Gogoi (₹6,160.98). These individual customers collectively account for around 7% of total profits.
- These customers are bulk buyers or loyal clients who make regular purchases.
- The "Others" category contributes ₹19,222 to total profits (approximately 4%). This group includes infrequent or one-time buyers.
- A small number of named customers contribute disproportionately to profits compared to the broader customer base.
- Building stronger relationships with these top-paying customers could further enhance profitability.
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- Building stronger relationships with these top-paying customers could further enhance profitability.

Interpretation of results

High-margin products contribute significantly to profits (₹350,000+), despite lower sales volumes. Examples include Kamakhya Paneer 200G (50% margin), Britannia NC Digestive 100GM (30%+ margin), and Lotte Choco Pie 25G (40% margin).

Recommendations:

- Promote High-Margin Items:
    - Highlight these products through in-store displays, online marketing campaigns, and targeted promotions.
    - Train staff to upsell these items during customer interactions.
- Bundle High-Margin Products with Staples:
    - Create combo deals where high-margin products are paired with popular staples like milk or eggs. For example, offer a discount on Kamakhya Paneer when purchased with Amul Tazza Milk.
- Expand Demand for Premium Products:
    - Use loyalty programs or discounts for repeat purchases of high-margin items to increase their sales volume.

Improve Management of Low/Negative-Margin Items

Low/negative-margin items generate revenue but result in net losses due to selling prices being lower than cost prices (SP < CP).

Recommendations:

- Reevaluate Pricing Strategies:
    - Conduct a cost-benefit analysis to explore price adjustments that improve margins without losing competitiveness.
    - Slightly increase the price of eggs or milk variants if market conditions allow.
- Negotiate Better Supplier Terms:
    - Work with suppliers to reduce procurement costs for low-margin items.
    - Explore alternative suppliers or bulk purchasing agreements to secure better pricing.
- Use Staples Strategically as Loss Leaders:
    - Continue selling these items at competitive prices but focus on using them to attract customers who also purchase high-margin products.

Optimize Customer Segmentation Strategies

Cash Customers

- Representing a dominant share (**89%**) of total profits, cash customers are critical to business success.

  Recommendations:

  - Introduce a loyalty program where cash customers earn points for every purchase. Points can be redeemed for discounts on high-margin items like Britannia Digestive Biscuits or Vim Bar.

Named Customers

- Named customers like "5C," "JITU DAA NOTH GHY," "AITA," and "GOGOI" collectively contribute ~7% of profits despite being fewer in number.

  Recommendations:

  - Offer personalized discounts or bulk purchase incentives tailored to these customers' buying patterns.

Others Category

- The "Others" category contributes only ~4% of profits, indicating untapped potential among infrequent buyers.

  Recommendations:

  - Convert one-time buyers into repeat customers by offering discount vouchers for their next purchase.
  - Run targeted campaigns promoting popular staples or bundles to attract occasional buyers

Products to Stock Consistently

High-Demand Staples

- **Eggs**, **Amul Tazza Milk (200ML, 500ML, 1L)**, **Potatoes**, and **Onions** are high-selling staples that drive customer traffic. Despite their low/negative margins, these items are essential for maintaining customer loyalty and generating consistent revenue.

  Plan:

  - Ensure these items are always in stock to avoid losing customers to competitors.

- Use these staples as "loss leaders" by bundling them with high-margin products like Kamakhya Paneer or Britannia Digestive Biscuits.

High-Revenue, High-Margin Products

- Items like **Kamakhya Paneer 200G**, **Britannia NC Digestive 100GM**, **Vim Bar 60G+10G**, and **Lotte Choco Pie 25G** have high profit margins (30–50%) and contribute significantly to overall profitability.

  Plan:

  - Prioritize these products in inventory management to ensure consistent availability.
  - Promote these items through targeted marketing campaigns or loyalty programs to boost sales.

Moderate-Margin Products

- Products like **Dhara Kachi Ghani Mastered Oil 1L**, **Moong Dal 500GM**, and **Slice Bread 200GM** provide stable contributions to revenue and profit. These items balance demand and profitability.

  Plan:

  - Maintain adequate stock levels for these items as they offer a reliable source of income.
  - Promote them alongside high-selling staples to increase their visibility.

  Low Margin Products

  Perishable items with low sales volumes are at a higher risk of spoilage. For example, niche products like certain dairy items or specialty foods that do not sell frequently should be monitored closely.

  Plan:

  - Reduce order quantities for such items unless demand increases significantly through promotions or bundling strategies.
  - Consider discontinuing low-selling perishables that consistently result in wastage.

Link to colab, sheet