The City College of New York

ECON 32500, Fall 2024, Final Project

Team Member:
Emir Dincer

Question:

What actions can the company take to increase profits over the last quarter?

Justification:
This question is valuable to the future of the company, attempting to find actionable solutions to increase profits from the last quarter, which happen to be very low. There needs to be a positive stream or else the company risks falling under.

Data Sources:
Data has been retrieved from SQL database.

1. **Sales Data:** Order details such as order date and quantity
2. **Products:** Product details like name, cost, and revenue.
3. **Stores:** Store location and size.
4. **Customer Data:** Demographics and spending patterns

Information is present from 2016 up until the beginning of Q1 in 2021.

Libraries:

1. Pandas - For working with Data
2. SQLAlchemy - Extracting relevant data from SQL database
3. Pyplot/Seaborn - Plotting data
4. Datetime - Datetime data manipulation

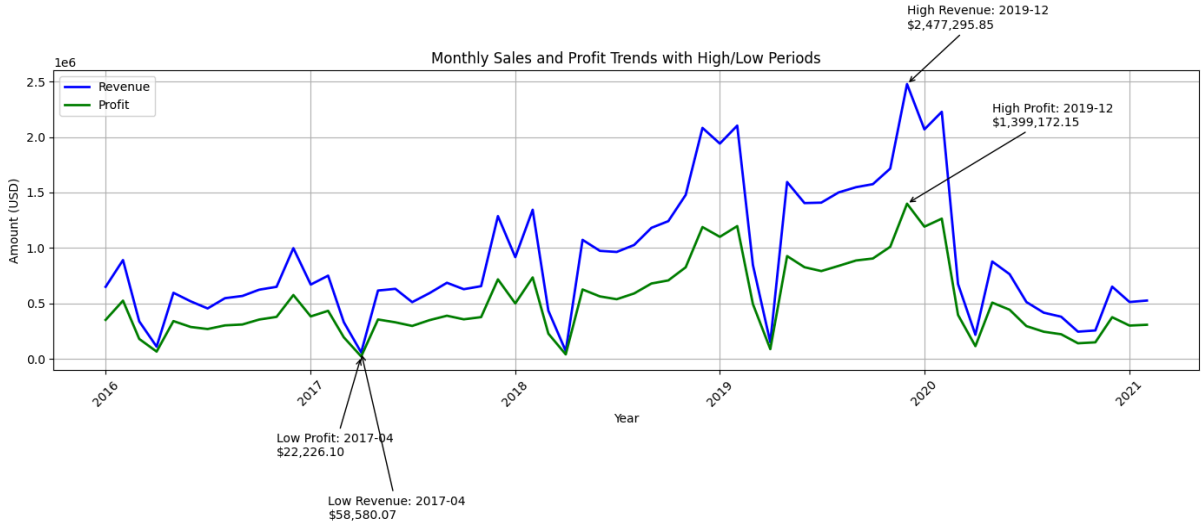
Data Preparation:

1. **SQL Data Ingestion**
   Data was imported from an SQL database using Pandas and SQLAlchemy. Specific fields were extracted from five tables (`proj_customers`, `proj_sales`, `proj_products`, `proj_exchange_rates`, and `proj_stores`) to minimize unnecessary overhead while focusing on relevant metrics.
2. **Column Renaming and Standardization**
   Column names were standardized for consistency and ease of analysis. For example, `Product_Name` was renamed to `ProductName`, and `Square_Meters` was updated to `StoreSize` across tables.
3. **Data Merging**
   The individual tables were joined on common keys:
   - `proj_sales` merged with `proj_products` using `ProductKey`
   - `proj_sales` merged with `proj_stores` using `StoreKey`
     This allowed the calculation of derived metrics such as `Revenue` and `Profit` at a product and store level.
4. **Revenue and Profit Calculation**
   - A `revenue_per_unit` column was created as the difference between `Unit_Price_USD` and `Unit_Cost_USD`.
   - The `Revenue` and `Profit` for each product were calculated as:
     - **Revenue** = `Quantity × Unit_Price_USD`
     - **Profit** = `Quantity × revenue_per_unit`.
5. **Datetime Processing**
   The `Order_Date` column was converted to a datetime format. From this, additional time-based features such as **Month**, **Year**, and **Quarter** were extracted for time-series analysis.
6. **Monthly Sales Trends**
   Sales performance was aggregated at a monthly level. Total `Revenue` and `Profit` trends were visualized to highlight high-performing and underperforming periods. Annotated plots identified key dips and peaks.
7. **Dip Period Analysis**
   Monthly revenue changes were calculated to identify the top 10 periods with the steepest revenue drops. This provided insights into recurring weak points (e.g., Q1 declines).
8. **Regional Sales and Store Efficiency**
   Regional sales were analyzed by merging `sales_data` with `stores_data`. Store profitability and efficiency were calculated as:
   - **Efficiency** = `Profit ÷ StoreSize`.
     The top-performing regions by profit and efficiency were identified and visualized.
9. **Product Performance Analysis**
   Products were grouped by quantity sold and profit generated.
   - **Top 5 Products by Quantity Sold**: Products with the highest sales volumes.
   - **Top 5 Products by Profitability**: Products contributing most significantly to profit margins. These insights were visualized to highlight trends and identify underperforming items.

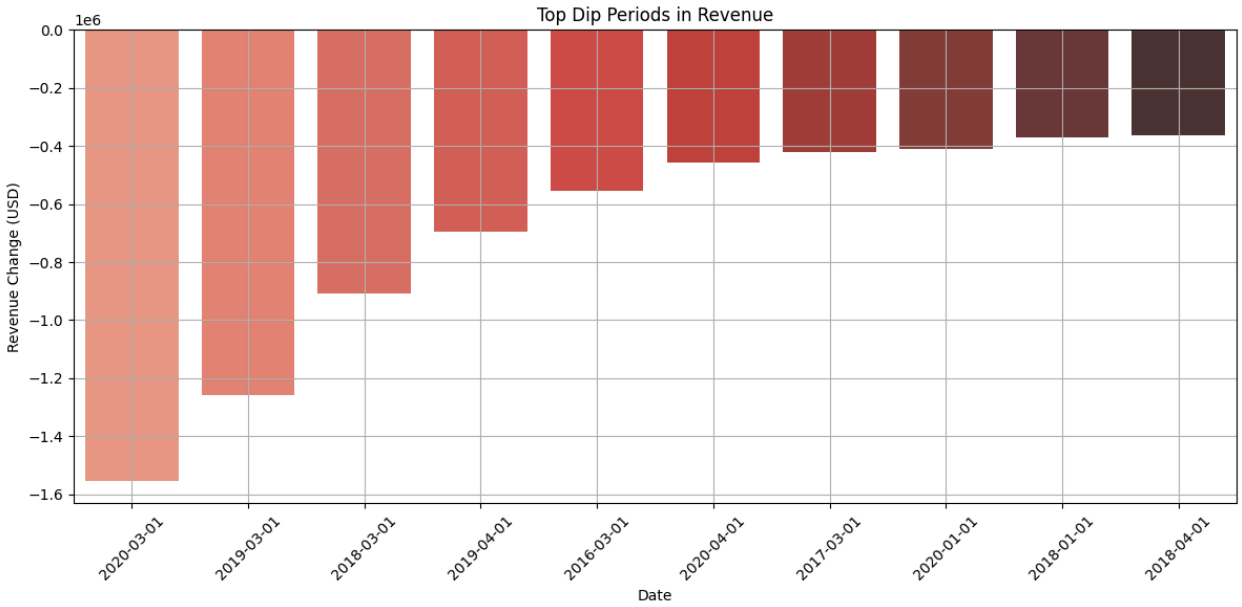
10. **Quarterly Comparisons (Q1 vs Q4)**
    To investigate seasonal trends, product performance in Q1 and Q4 was compared across years:
    - Top 3 most profitable products in each quarter were identified.
    - Average unit prices for Q1 and Q4 were calculated to determine price adjustments or discounts.
    - Products were categorized as **Discounted** or **Undiscounted** based on price variations.
11. **State-Level Analysis**
    Store performance was aggregated by state to identify:
    - **Top 5 States by Profit**
    - **Top 5 States by Efficiency** (Profit per square meter).
      A combined visualization showcased regional disparities and highlighted key areas for improvement.
12. **Visualization and Reporting**
    All findings were visualized using Matplotlib and Seaborn to provide clear insights.
    Visualizations included:
    - Monthly sales and profit trends.
    - Regional profitability analysis.
    - Top products by quantity and profit over time.
    - Q1 vs Q4 product comparisons.
    - State-level efficiency and profitability.

Data Analysis:

To identify opportunities for improving sales performance, we started with the big picture. The first step was to analyze overall trends, looking at how sales performed across multiple years and identifying patterns that stood out. One critical finding quickly emerged: a steep dip in Q1 following the previous year's Q4 peak. This consistent drop-off raised the question: *What's driving this decline, and how can we fix it?*

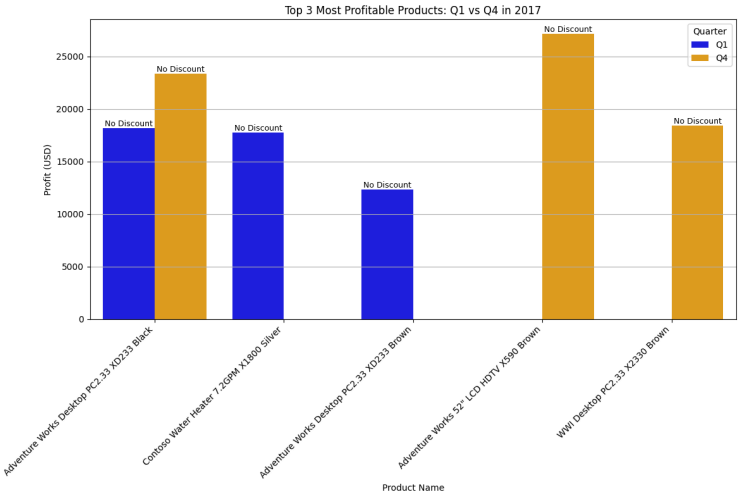


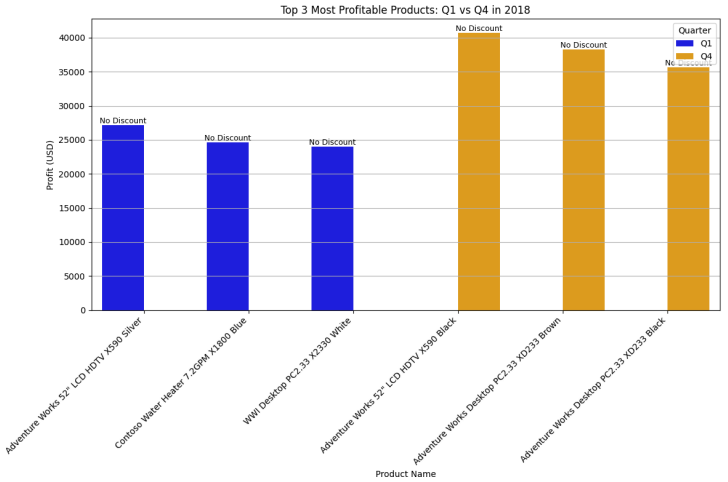
We've seen consistent sales dips in specific periods, with some products performing exceptionally well in terms of profitability but failing to sustain momentum.

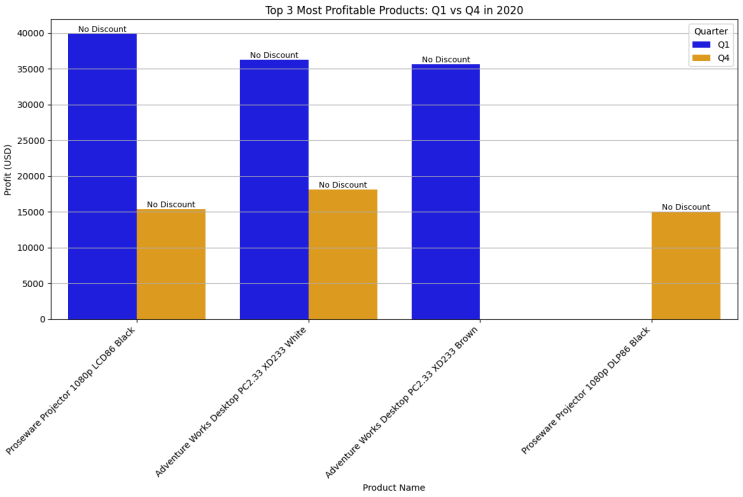


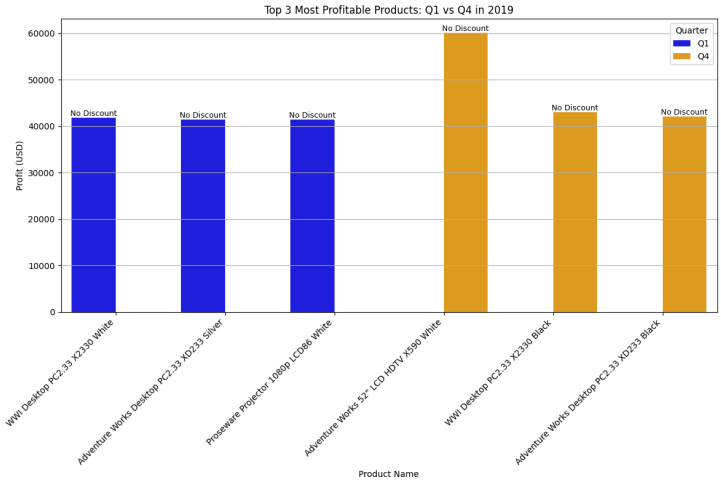
In the new plot, it was believed to see the best dip of sales by looking at the revenue. This plot was calculated to show during what dates saw the biggest dips, and they were all around January-April, meaning a historically very weak Q1 dropoff.

Once we identified the Q4 to Q1 sales dip, we investigated further to understand why certain products performed poorly. This led us to uncover two key patterns: high-quantity, low-profit products and underperforming profitable items.

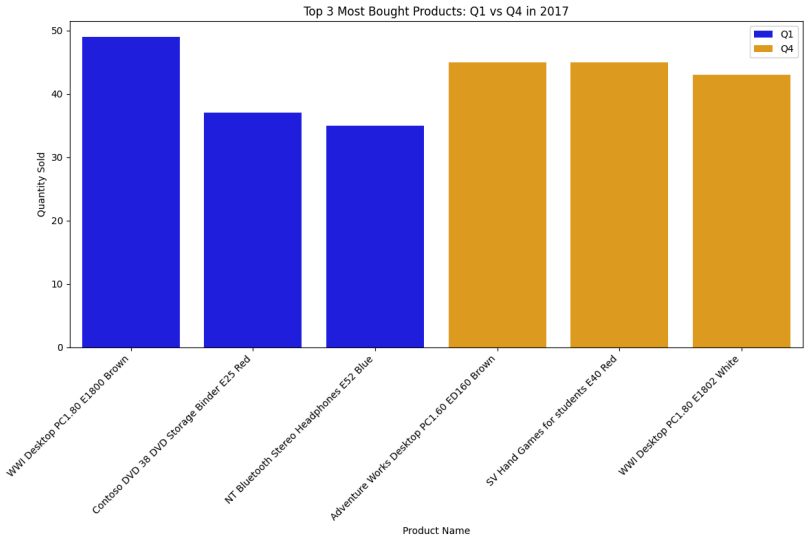


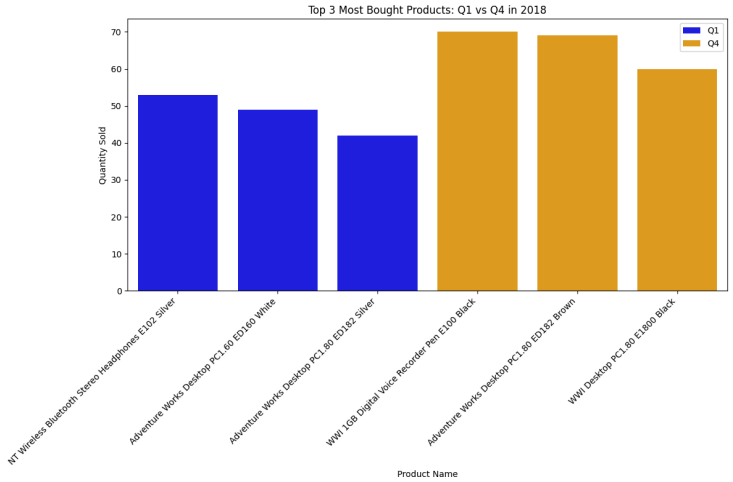


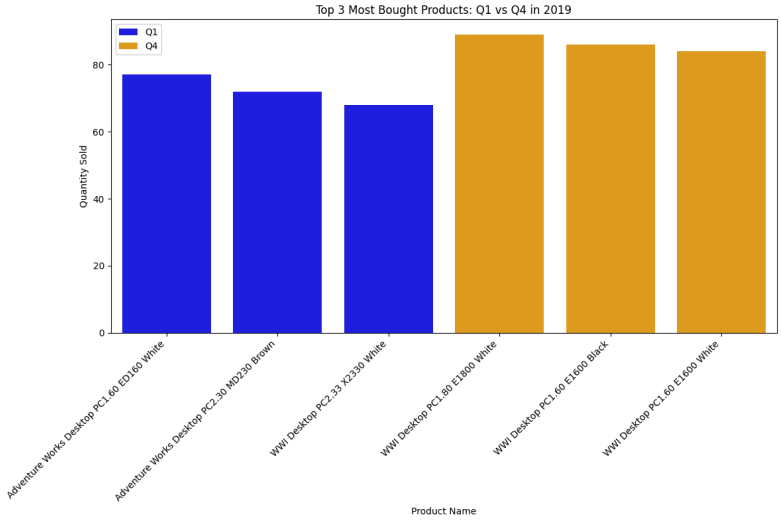


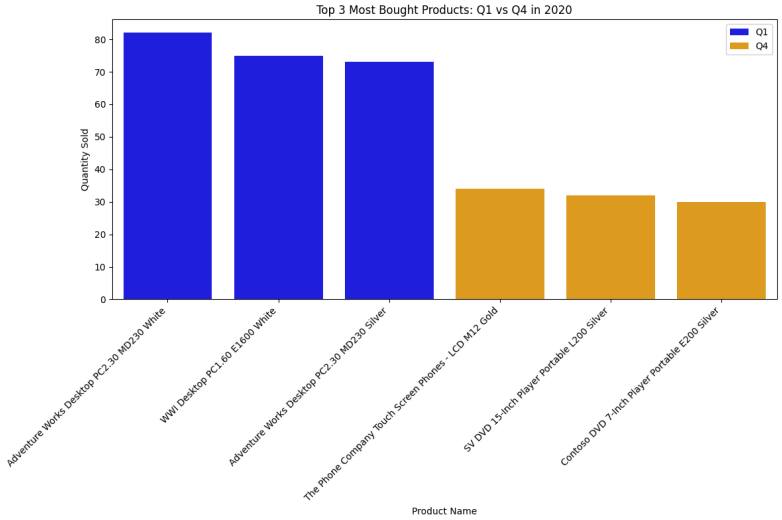


Generally, there was little overlap historically on products in Q1 and Q4, but Q4 products saw more profitability. It is crucial to note that 2020 was the only year that showed a large margin of higher profitability during Q1 compared to Q4, likely due to COVID-19 lockdowns. However, this data also highlights the lack of sales momentum. All the products in Q1 and Q4 were bought at full price, and no sale attached.

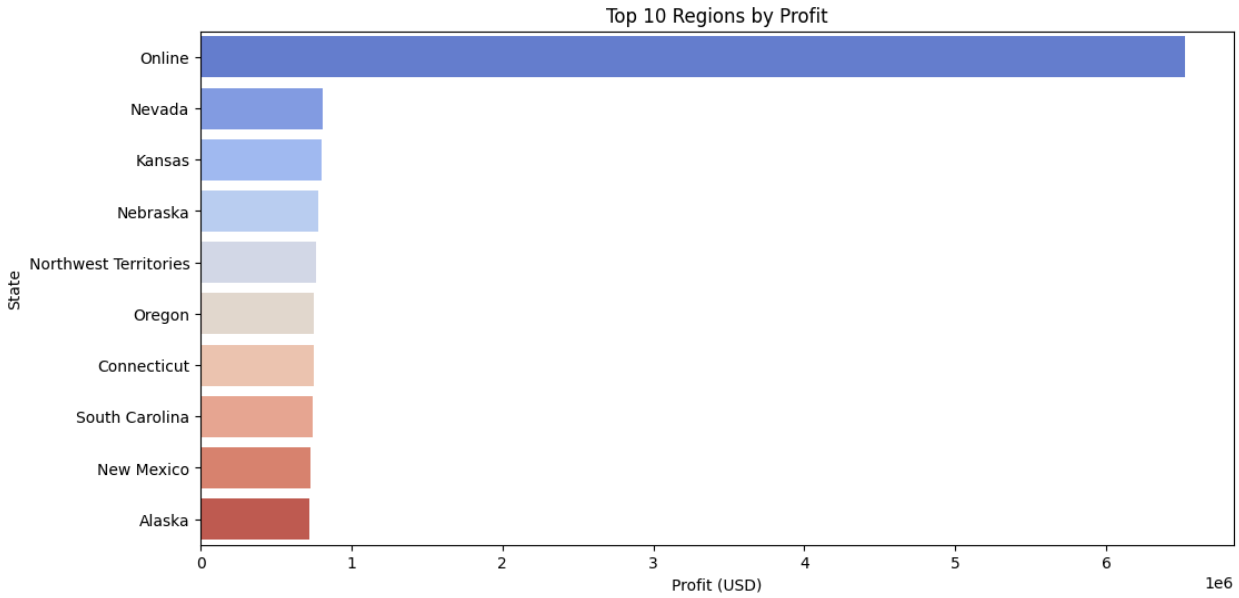




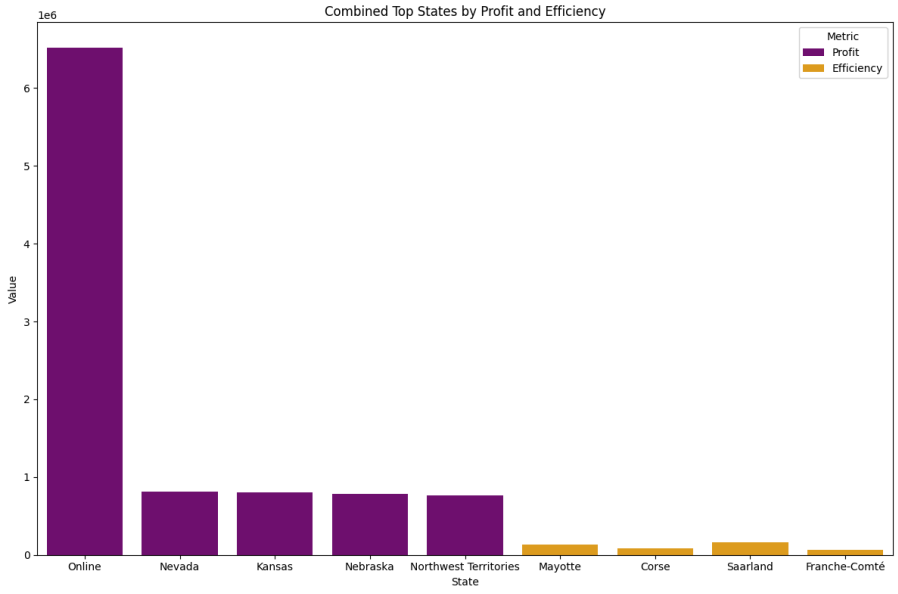




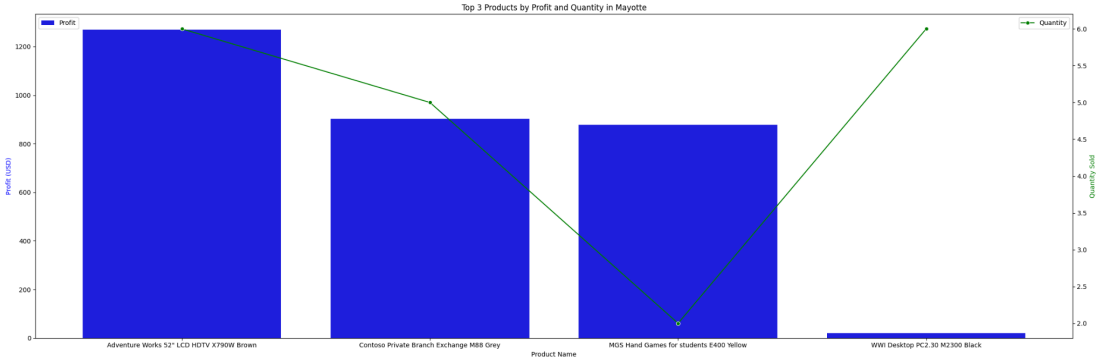
This further proves the point that the number of sales isn't going down, but the profitable items aren't being sold as much. We see around a 90% drop in revenue between Q4 2017 to Q1 2018, but the quantity sold for two of the top selling desktops of the quarter were about the same, just not as profitable.

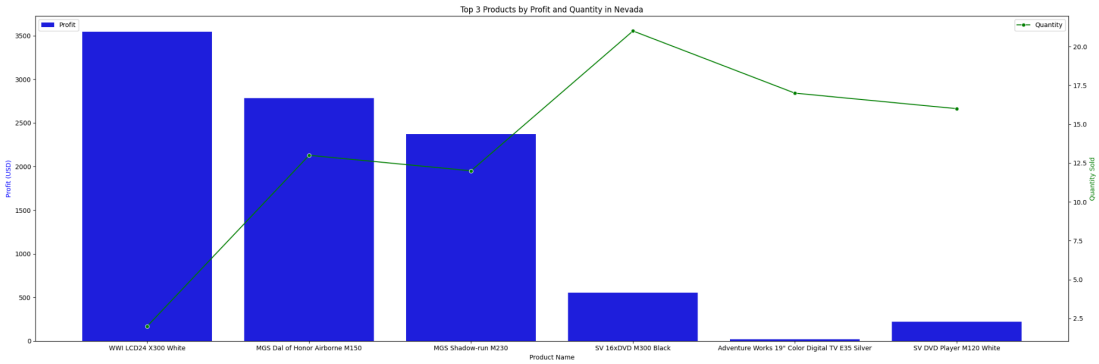


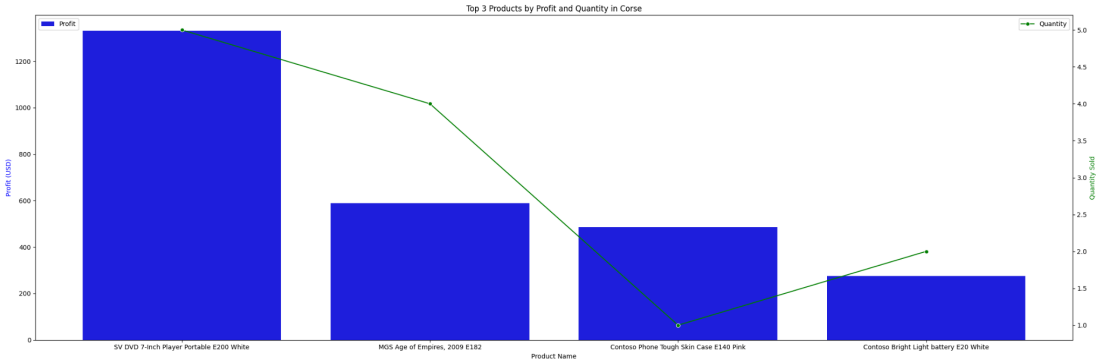
Next, we analyzed where sales originated. Online sales dominated, generating over six times the revenue of the top physical store. To uncover opportunities, we focused on what makes stores successful—examining their size, efficiency, and top-performing products. This analysis aimed to identify strategies that could bring physical store performance closer to the impressive momentum of online sales.

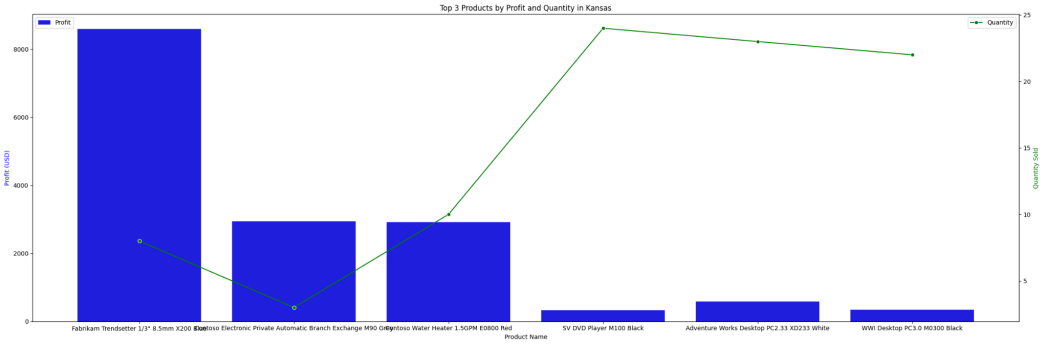


The most space-efficient stores were the smallest, all located in France.


Top 3 Products by Profit and Quantity in Mayotte
Profit
Quantity
Profit (USD)
Quantity Sold
Product Name
Adventure Works 52" LCD HDTV X790W Brown
Contoso Private Branch Exchange M88 Grey
MGS Hand Games for students E400 Yellow
WWI Desktop PC2.30 M2300 Black

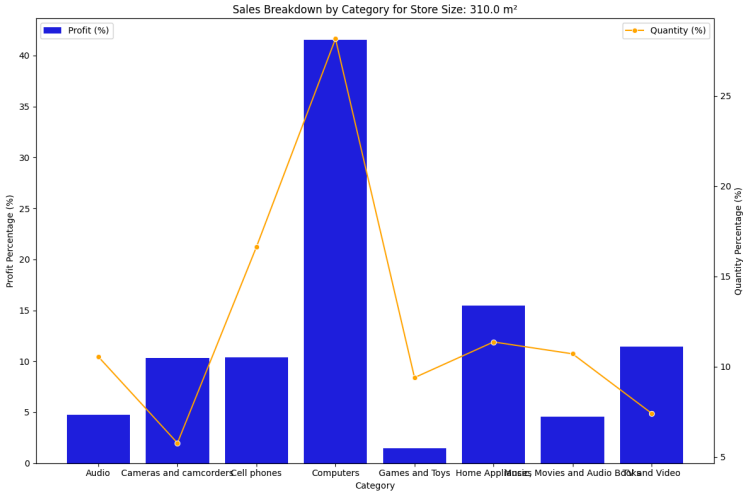

Top 3 Products by Profit and Quantity in Nevada
Profit
Quantity
Profit (USD)
Quantity Sold
Product Name
WWI LCD24 X300 White
MGS Dal of Honor Airborne M150
MGS Shadow-run M230
SV 16xDVD M300 Black
Adventure Works 19" Color Digital TV E35 Silver
SV DVD Player M120 White

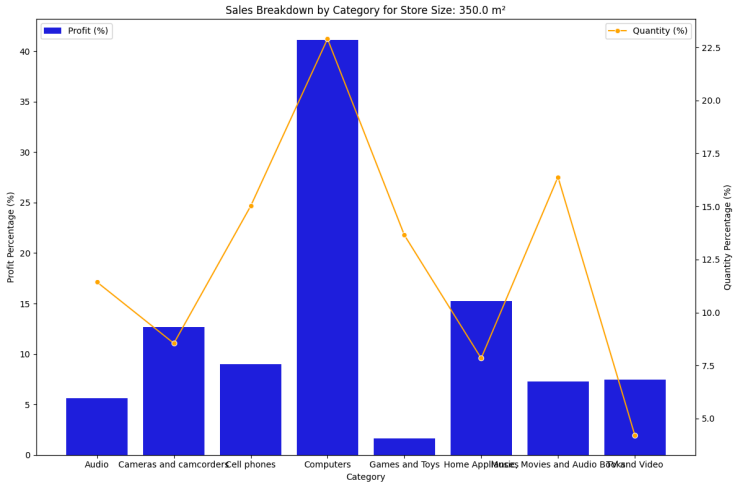

Top 3 Products by Profit and Quantity in Corse
Profit
Quantity
Profit (USD)
Quantity Sold
Product Name
SV DVD 7-inch Player Portable E200 White
MGS Age of Empires, 2009 E182
Contoso Phone Tough Skin Case E140 Pink
Contoso Bright Light battery E20 White

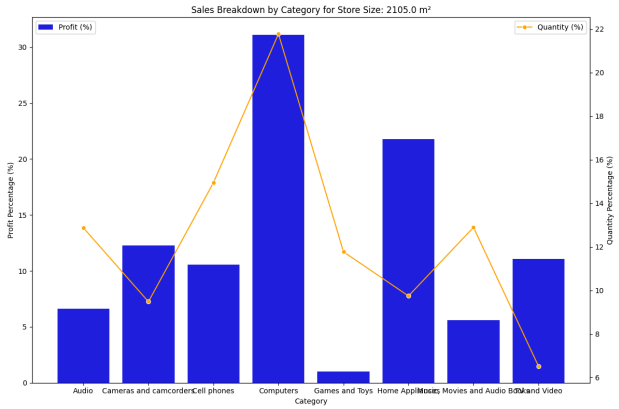

Top 3 Products by Profit and Quantity in Kansas
Profit
Quantity
Profit (USD)
Quantity Sold
Product Name
Fabrikam Trendsetter 1/3" 8.5mm X200 Black
Contoso Electronic Private Automatic Branch Exchange M90 Grey
Contoso Water Heater 1.5GPM E0800 Red
SV DVD Player M100 Black
Adventure Works Desktop PC2.33 XD233 White
WWI Desktop PC3.0 M0300 Black

We can see in the top 2 most profitable stores vs the top 2 most efficient stores based on square meter, the profit comes from different products, meaning different stores have different needs and demands.

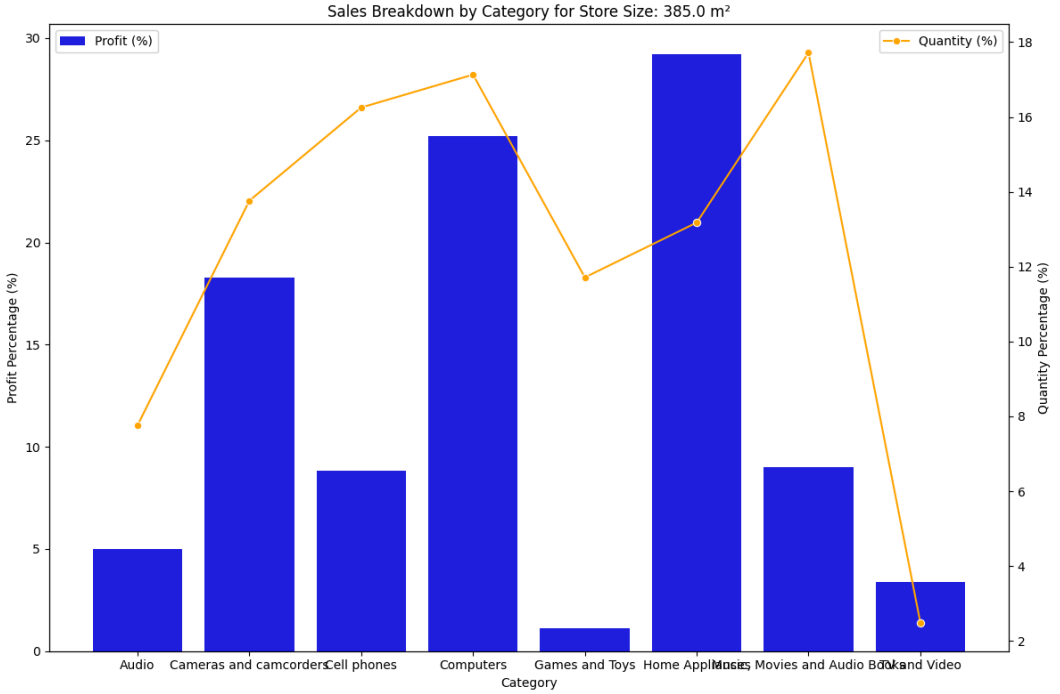
Stores in Corse (245m^2) and Mayotte (310m^2) compared to stores in Nevada (2000m^2) and Kansas (2000m^2). All of the top products are in fact different from one another. Also, we see a general trend that the demand for products aren't nearly as profitable, selling at nearly 5x of the amount sold, yet a fraction of the profit being made in comparison.







The store size is important to note, because there is a different skew of demand for certain products, as well as a different profit margin. Even though Computer sales make up about 35-40% of the profit and 20-25% of the quantity in sales, all the other categories are different in terms of product sales and profitability. Here are three examples from Saarland, Mayotte, and the largest store in Newfoundland and Labrador (2105 m^2). Computer sales make up for about 40% of the profit in these French stores whereas it only makes up about 30% in Canada. Furthermore Home Appliances make up about 20% of the sales in Canada, but only about 15% of the sales in the French stores.



An interesting outlier, the Limousin store in France (385m^2), derives 20% of its profit and 14% of its sales volume from Cameras and Camcorders, highlighting unique local demand. Different stores have different needs, and it is beneficial to note when taking action. These are just some of the stores and a part of the story.

Actionable Solutions to Improve Next Quarter Performance

1. **Address the Q4 to Q1 Sales Dip**

We began by observing a steep dip in sales in Q1 after the strong Q4 performance. To address the Q1 sales dip, we recommend targeted promotions for Q4's top-selling products, like the 'WWI Desktop PC2.33 Black.' Data (Pages 7–8) shows consistent quantity sold between Q4 and Q1, but profitability declines. Promoting these products in Q1 will sustain momentum and stabilize revenue.

As discovered on pages 7 and 8, we can see the problem isn't losing customer activity. Top Q4 products, like the 'WWI Desktop PC2.33 Black,' maintain consistent sales volumes into Q1, but profitability declines. Targeted Q1 promotions will help sustain demand and stabilize revenue. By smoothing out profitability, we can also stabilize incoming revenue, which will overall help reach the goal of an improvement in the next quarter.

2. **Optimizing Pricing for Misaligned Product Performance**

Data insight product-level analysis revealed two important points. High quantity, low profitability. On Page 9, we see items like "TV and Videos," "Music, Movies, and Audio Books," and "Games and Toys" all saw very high quantities, but low profitability.

Also, there was high quantity, and low profitability. There were certain instances where "Cameras and Camcorders" and "Home Appliances" had very high profitability but also very low amounts of purchases in French stores seen on Page 13.

By adjusting price strategies, there can be increased margins for high-quantity products through incremental price adjustments or premium options. There can also be visibility for profitable but underperforming products using target marketing. Optimizing pricing ensures high-quantity products generate better margins while targeted marketing increases visibility for profitable, underperforming products. Together, these strategies will maximize profits and balance sales distribution.

Conclusions:

By addressing the Q1 sales dip through targeted promotions for high-performing Q4 products, optimizing pricing for high-quantity, low-profit items, and enhancing visibility for profitable underperforming products, we can stabilize revenue and improve margins. Tailoring strategies to store-specific needs will further maximize efficiency and profitability, setting a clear path for stronger performance in the next quarter.