

Supply Chain Analytics

Aashay Zende, Apurv Garge, Armaan Munsiff,
Hemraj Saini, Prashant Singh, Raphael Assaf



Problem Statement

- We aim to delve into the challenges of order fulfillment, shipment, and inventory management, specifically tackling issues related to overstock and understock, and provide actionable insights for strategic decision-making
- Mistakes or delays in the process can result in increased expenses, unhappy customers, and decreased productivity.
- The insights gained will be valuable for business stakeholders, offering a decision-making tool through final dashboards. Prompt identification and resolution of supply chain inefficiencies are facilitated, and strategic recommendations derived from the findings can substantially improve the overall business structure and performance.

Datasets

https://github.com/farhadfarahanii/Supply_Chain_Analytics/tree/main/data

Three datasets:

- **Orders_and_shipments.csv**
 - The biggest dataset containing 24 columns with information about each order (OrderID, order date, profit, customer info, etc)
- **Fulfillment.csv**
 - Dataset with two columns (product name & warehouse order fulfillment)
 - Info about the amount of time it takes for a warehouse to complete the process of fulfilling an order, from the time the order is placed until it is ready for shipment.
- **Inventory.csv**
 - Three columns (product name, year month, warehouse inventory, inventory cost per unit)
 - Contains important information about warehouse inventory and associated costs



orders_and_shipments.csv

Product Name

Order Year Month

Customer

Shipment date

inventory.csv

Product Name

Year Month

Warehouse Inventory

Inventory cost per unit

fulfilment.csv

Product Name

Warehouse Order fulfilment
(days)

This image explains how three separate datasets can be integrated based on common fields:

- **orders_and_shipments.csv**: Contains detailed order information, including product names and the dates of orders.
- **inventory.csv**: Tracks inventory levels by product and time (year and month), along with cost information.
- **fulfillment.csv**: Details the time it takes for each product to be fulfilled by the warehouse.

The linkage between the datasets is based on the 'Product Name' and 'Order Year Month' (which corresponds to 'Year Month' in the inventory dataset). These common fields suggest that data from each file can be merged to analyze orders, inventory status, and fulfillment performance together.

orders_and_shipments.csv

| | Order ID | Order Item ID | Order YearMonth | Order Year | Order Month | Order Day | Order Time | Order Quantity | Product Department | Product Category | ... | Customer Country | Warehouse Country | Shipment Year | Shipment Month | Ship |
|-------------------------|----------|---------------|-----------------|------------|-------------|-----------|------------|----------------|--------------------|--------------------|-----|------------------|-------------------|---------------|----------------|------|
| 0 | 3535 | 8793 | 201502 | 2015 | 2 | 21 | 14:07 | 1 | Fan Shop | Fishing | ... | Mexico | Puerto Rico | 2015 | 2 | |
| 1 | 4133 | 10320 | 201503 | 2015 | 3 | 2 | 07:37 | 1 | Fan Shop | Fishing | ... | Brazil | Puerto Rico | 2015 | 3 | |
| 2 | 7396 | 18517 | 201504 | 2015 | 4 | 18 | 22:47 | 1 | Fan Shop | Fishing | ... | Mexico | Puerto Rico | 2015 | 4 | |
| 3 | 11026 | 27608 | 201506 | 2015 | 6 | 10 | 22:32 | 1 | Fan Shop | Fishing | ... | Denmark | Puerto Rico | 2015 | 6 | |
| 4 | 11026 | 27609 | 201506 | 2015 | 6 | 10 | 22:32 | 1 | Fan Shop | Fishing | ... | Denmark | Puerto Rico | 2015 | 6 | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 30866 | 73246 | 176561 | 201712 | 2017 | 12 | 5 | 04:59 | 1 | Fan Shop | Toys | ... | Australia | Puerto Rico | 2017 | 12 | |
| 30867 | 7908 | 19762 | 201504 | 2015 | 4 | 26 | 10:10 | 1 | Fan Shop | Hunting & Shooting | ... | Paraguay | Puerto Rico | 2015 | 4 | |
| 30868 | 29326 | 73368 | 201603 | 2016 | 3 | 4 | 01:51 | 1 | Fan Shop | Hunting & Shooting | ... | India | Puerto Rico | 2016 | 3 | |
| 30869 | 63308 | 158284 | 201707 | 2017 | 7 | 13 | 03:15 | 1 | Fan Shop | Hunting & Shooting | ... | Germany | Puerto Rico | 2017 | 7 | |
| 30870 | 67951 | 169874 | 201709 | 2017 | 9 | 18 | 21:54 | 1 | Fan Shop | Water Sports | ... | Italy | Puerto Rico | 2017 | 9 | |
| 30871 rows × 24 columns | | | | | | | | | | | | | | | | |

fulfillment.csv

| | Product Name | Warehouse Order Fulfillment (days) |
|-----|---|------------------------------------|
| 0 | Perfect Fitness Perfect Rip Deck | 8.3 |
| 1 | Nike Men's Dri-FIT Victory Golf Polo | 6.6 |
| 2 | O'Brien Men's Neoprene Life Vest | 5.5 |
| 3 | Nike Men's Free 5.0+ Running Shoe | 9.4 |
| 4 | Under Armour Girls' Toddler Spine Surge Runni | 6.3 |
| ... | ... | ... |
| 113 | Stiga Master Series ST3100 Competition Indoor | 4.7 |
| 114 | SOLE E35 Elliptical | 1.9 |
| 115 | Bushnell Pro X7 Jolt Slope Rangefinder | 2.0 |
| 116 | SOLE E25 Elliptical | 2.1 |
| 117 | Bowflex SelectTech 1090 Dumbbells | 7.7 |

118 rows × 2 columns

inventory.csv

| | Product Name | Year Month | Warehouse Inventory | Inventory Cost Per Unit |
|------|---|------------|---------------------|-------------------------|
| 0 | Perfect Fitness Perfect Rip Deck | 201712 | 0 | 0.69517 |
| 1 | Nike Men's Dri-FIT Victory Golf Polo | 201712 | 2 | 1.29291 |
| 2 | O'Brien Men's Neoprene Life Vest | 201712 | 0 | 0.56531 |
| 3 | Nike Men's Free 5.0+ Running Shoe | 201712 | 1 | 1.26321 |
| 4 | Under Armour Girls' Toddler Spine Surge Runni | 201712 | 0 | 1.47648 |
| ... | ... | ... | ... | ... |
| 4195 | TaylorMade 2017 Purelite Stand Bag | 201501 | 0 | 1.44662 |
| 4196 | Ogio Race Golf Shoes | 201501 | 0 | 0.10310 |
| 4197 | GolfBuddy VT3 GPS Watch | 201501 | 0 | 1.77747 |
| 4198 | Titleist Small Wheeled Travel Cover | 201501 | 0 | 0.15244 |
| 4199 | Polar Loop Activity Tracker | 201501 | 1 | 0.88259 |

4200 rows × 4 columns

Methods and Tools

Data Cleaning and Descriptive Analysis with Geographical Focus

First step is data cleaning, rectifying missing or inconsistent data, and standardizing formats for analytical coherence. This critical process ensures subsequent analyses' integrity, forming a reliable foundation.

Subsequently, a comprehensive descriptive analysis explores key statistics related to orders, shipments, fulfillment times, and inventory levels, providing a holistic understanding of supply chain dynamics.

Geographical focus on the USA, Canada, and Mexico enables tailored recommendations based on each market's unique characteristics.





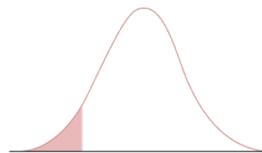
Hypothesis Testing (Excel or R)

A Hypothesis Test will be employed to examine mean profit differences for the two top-selling product categories

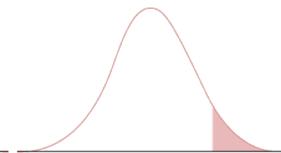
- $H(0)$: Mean profit earned from Cleats \leq Mean profit earned from Women Apparels
- $H(1)$: Mean profit earned from Cleats $>$ Mean profit earned from Women's Apparels

This statistical approach ensures the robustness of our findings and supports data-driven decision-making.

$$\begin{aligned} H_0 &: \mu = \text{claim} \\ H_1 &: \mu < \text{claim} \end{aligned}$$



$$\begin{aligned} H_0 &: p = \text{claim} \\ H_1 &: p > \text{claim} \end{aligned}$$

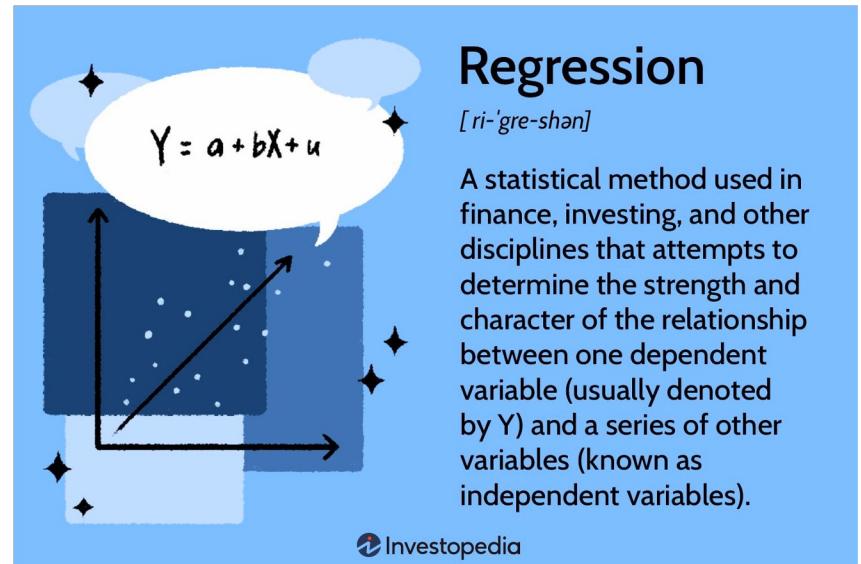


$$\begin{aligned} H_0 &: \beta = \text{claim} \\ H_1 &: \beta \neq \text{claim} \end{aligned}$$

Linear Regression (Python)

We will leverage *Python* for Linear Regression to create a predictive model for discounts.

This model will unveil relationships between variables and aid in understanding the factors influencing discount percentages.



Interactive Dashboards (Tableau & Power BI)

Interactive dashboards, created using Tableau or Power BI, will be developed to visualize the analysis.

Shipment Analysis- focused on highlighting delayed orders and average delay times.

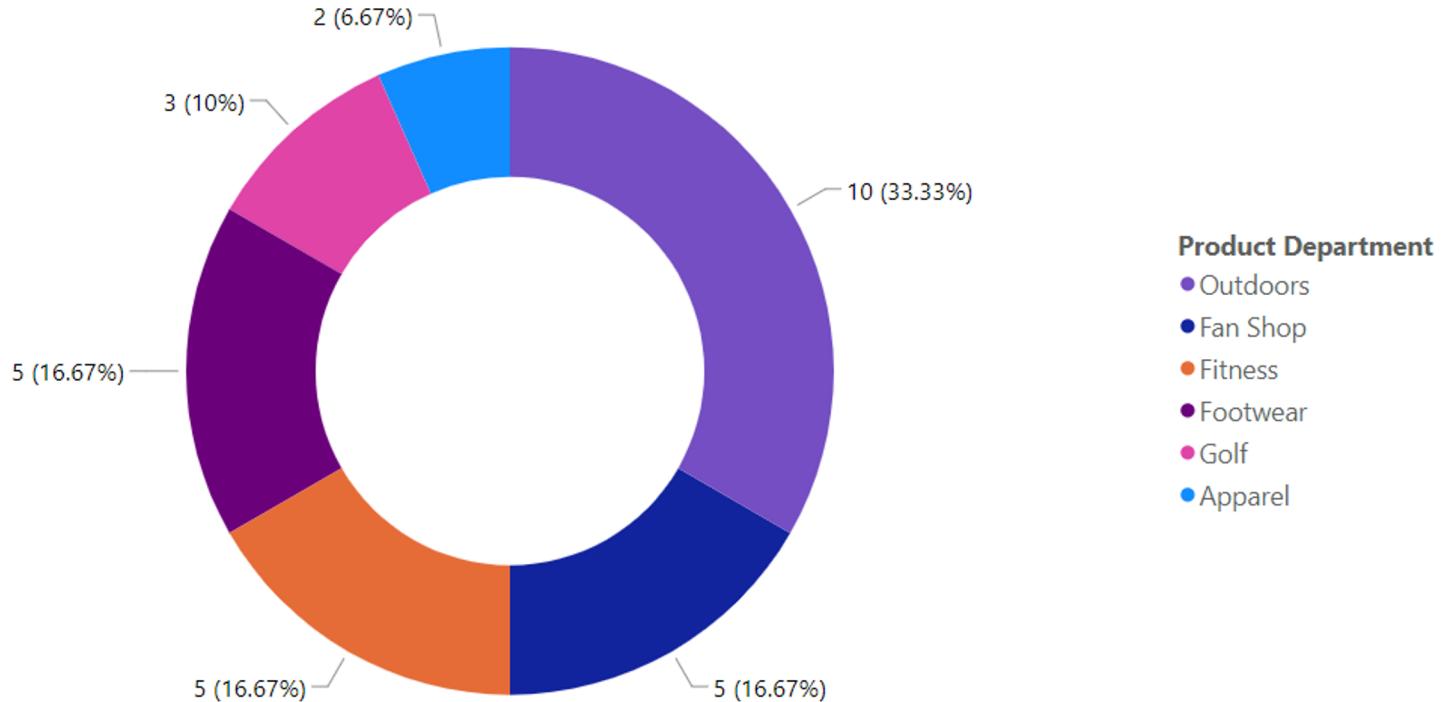
Inventory Analysis- focused on assessing supply and demand dynamics alongside stock levels.

These dashboards serve as intuitive tools for stakeholders to glean actionable insights from the data.



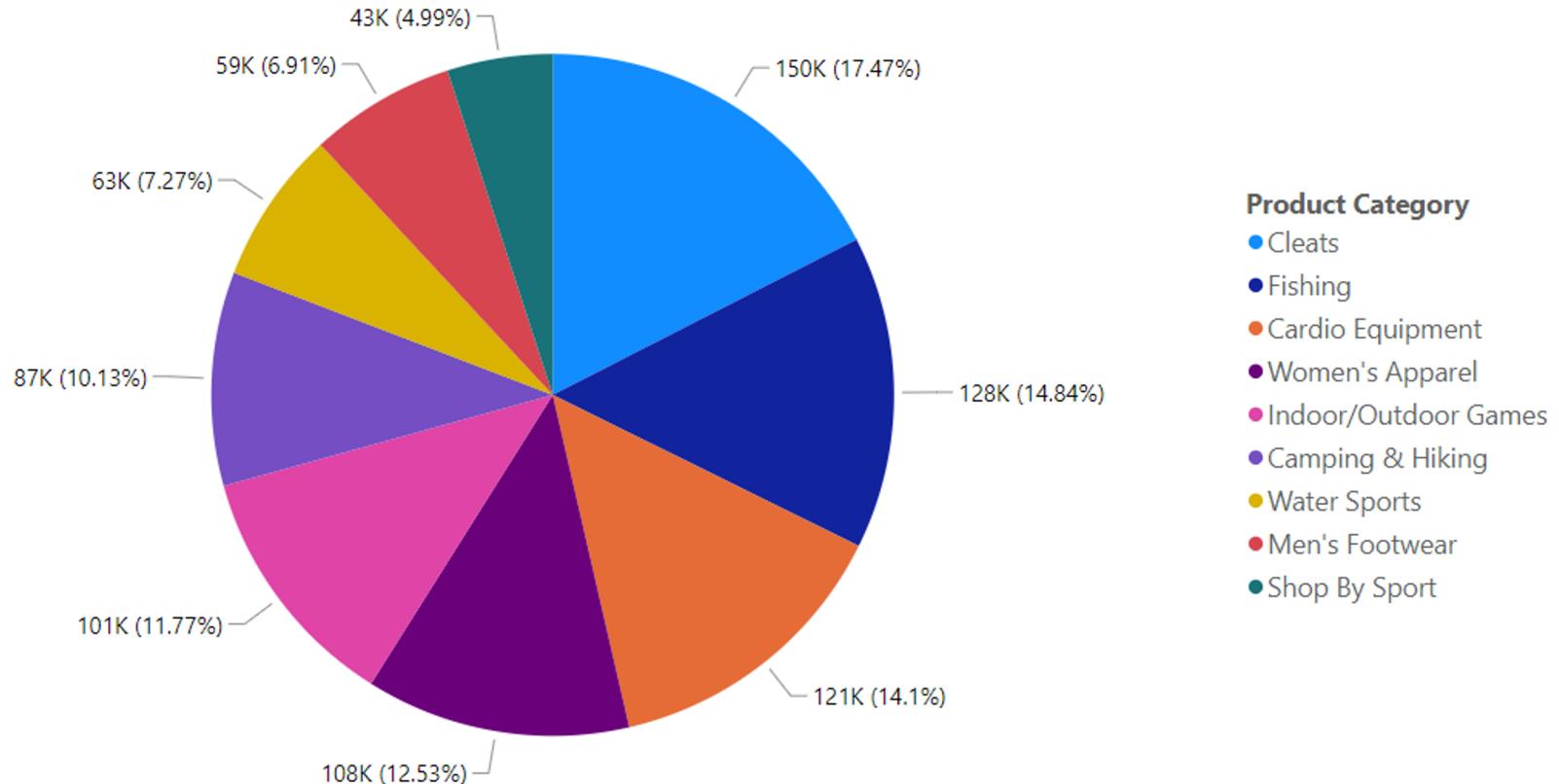
Exploratory Visualizations

Count of Product Category by Product Department



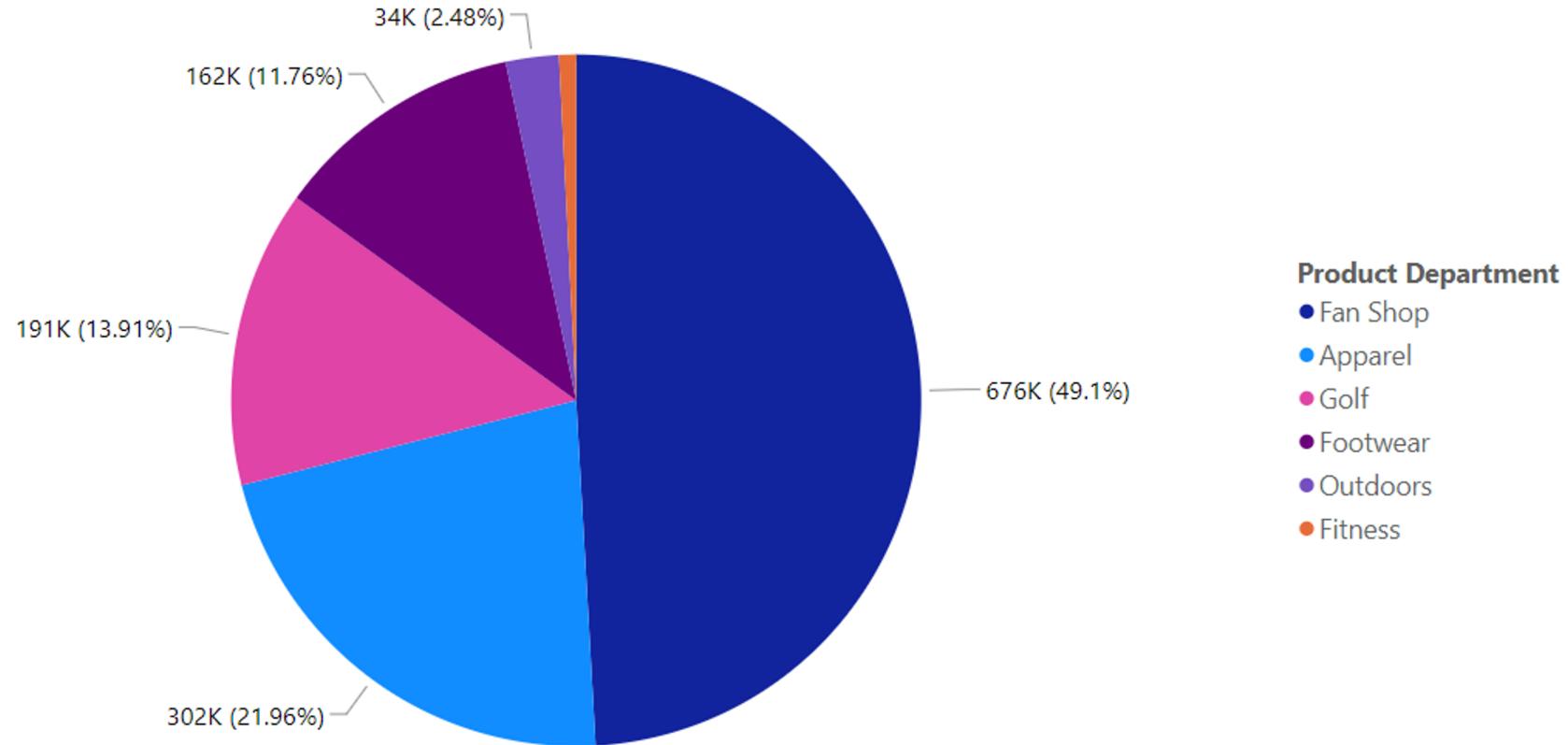
The donut chart illustrates the distribution of product categories across various departments, with Outdoor department having maximum categories (10) for the largest share at 33.33% and Apparel the smallest at 6.67%.

Profit by Product Category



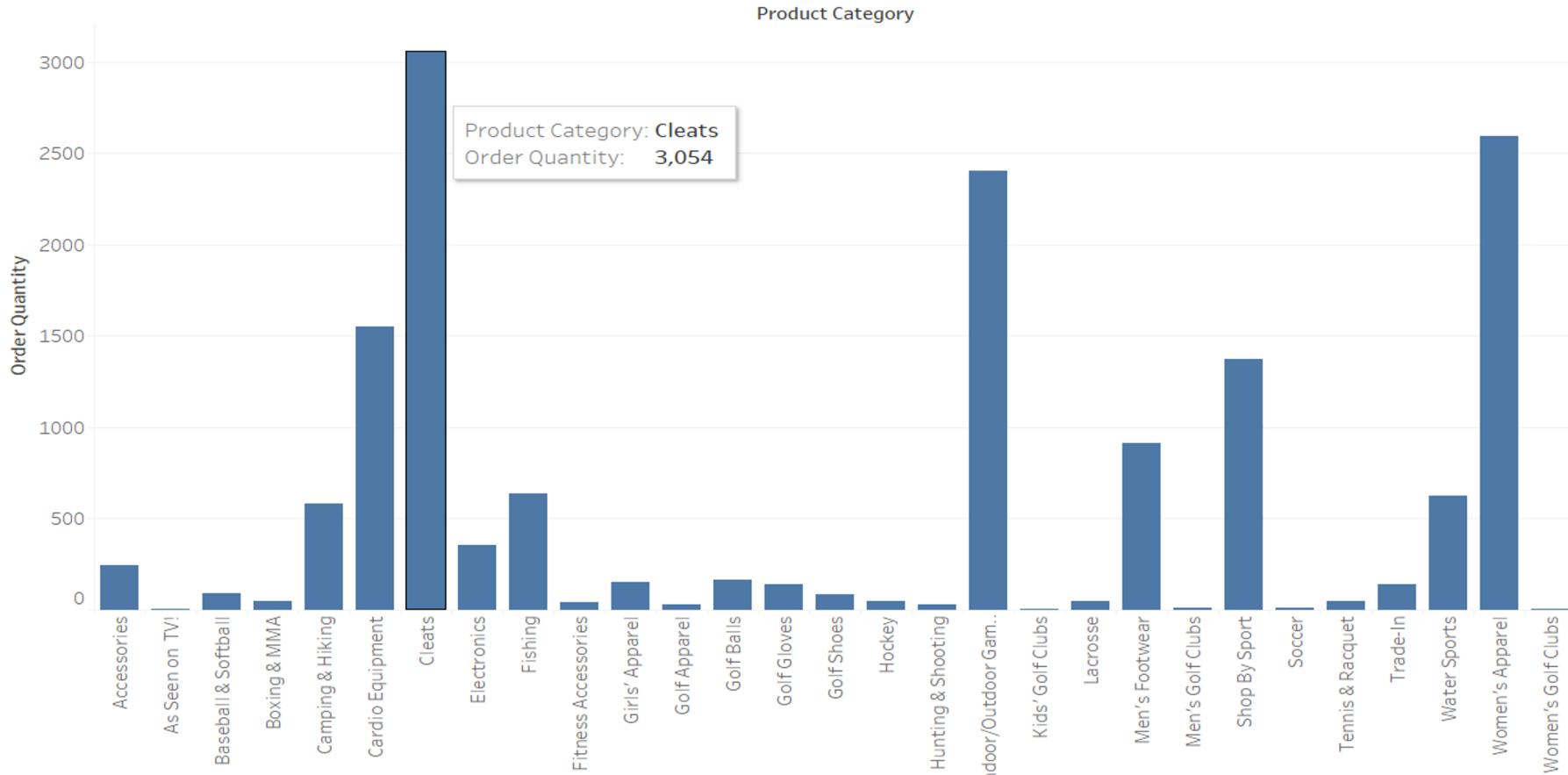
The pie chart depicts the profit distribution of product category gaining profits above \$42K, with Cleats being the most profitable at 150K (17.47%)

Gross Sales by Product Department



The pie chart depicts the Gross Sales per Product Department, with Fan Shop sharing approx 50% of the sales and Fitness with the least contribution.

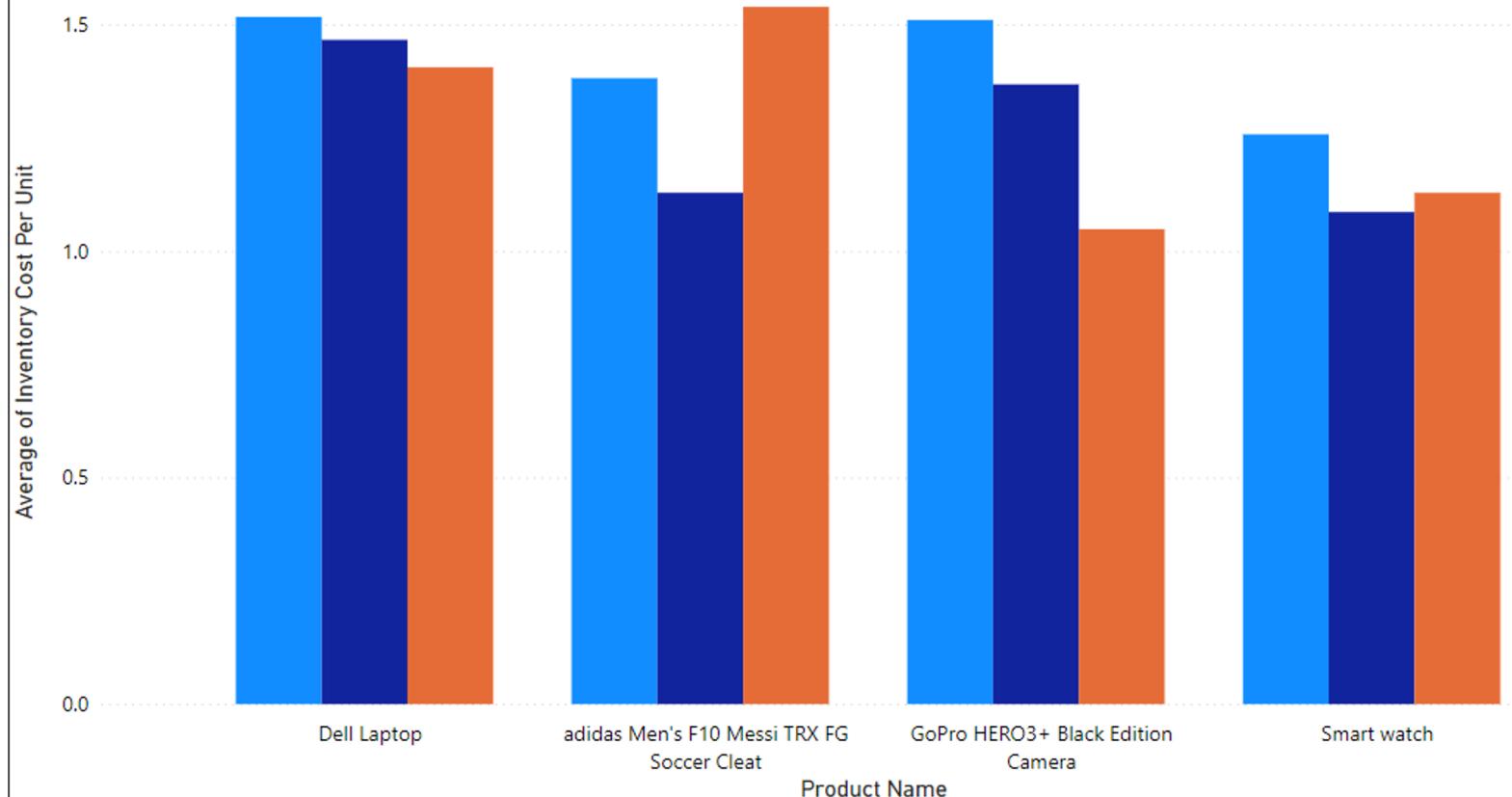
Top Selling Categories



Cleats and Women's Apparel are top 2 selling categories based on the Order Quantity.

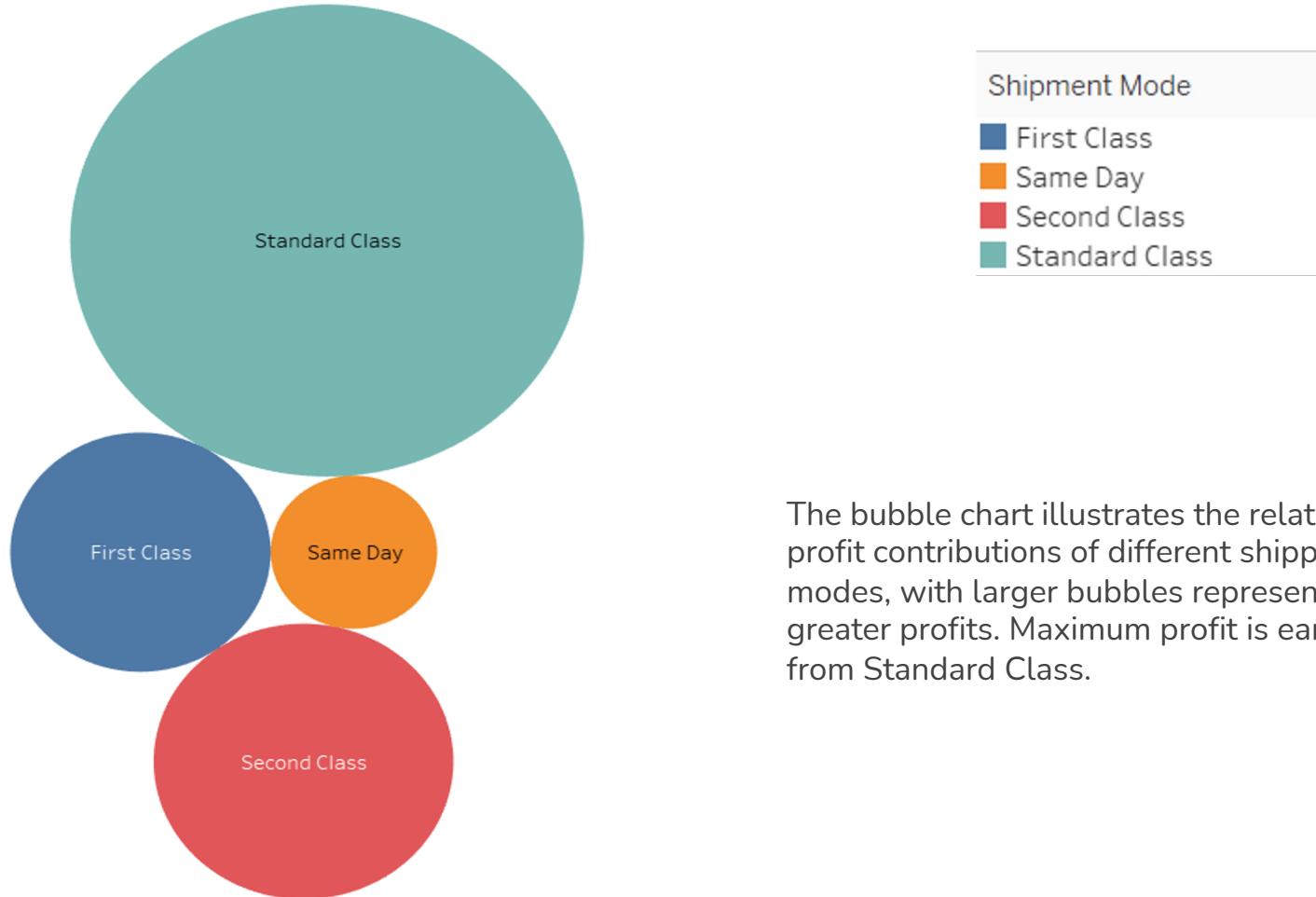
Average of Inventory Cost Per Unit by Product Name and Year

Year ● 2015 ● 2016 ● 2017

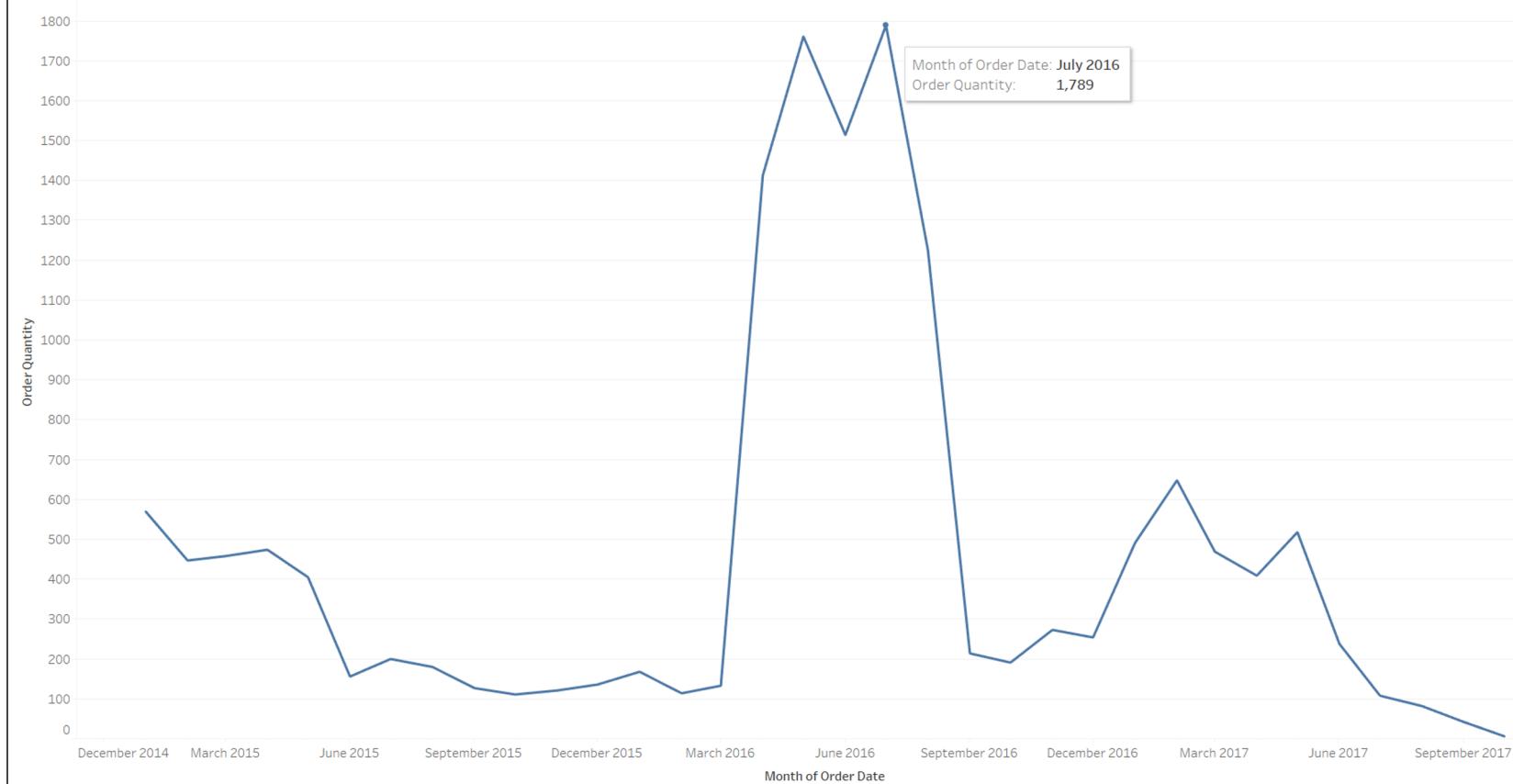


The bar chart compares the average inventory cost per unit of five products over three years, showing inventory cost trends for each product from 2015 to 2017.

Bubble chart for Profit earned from each Shipment Mode

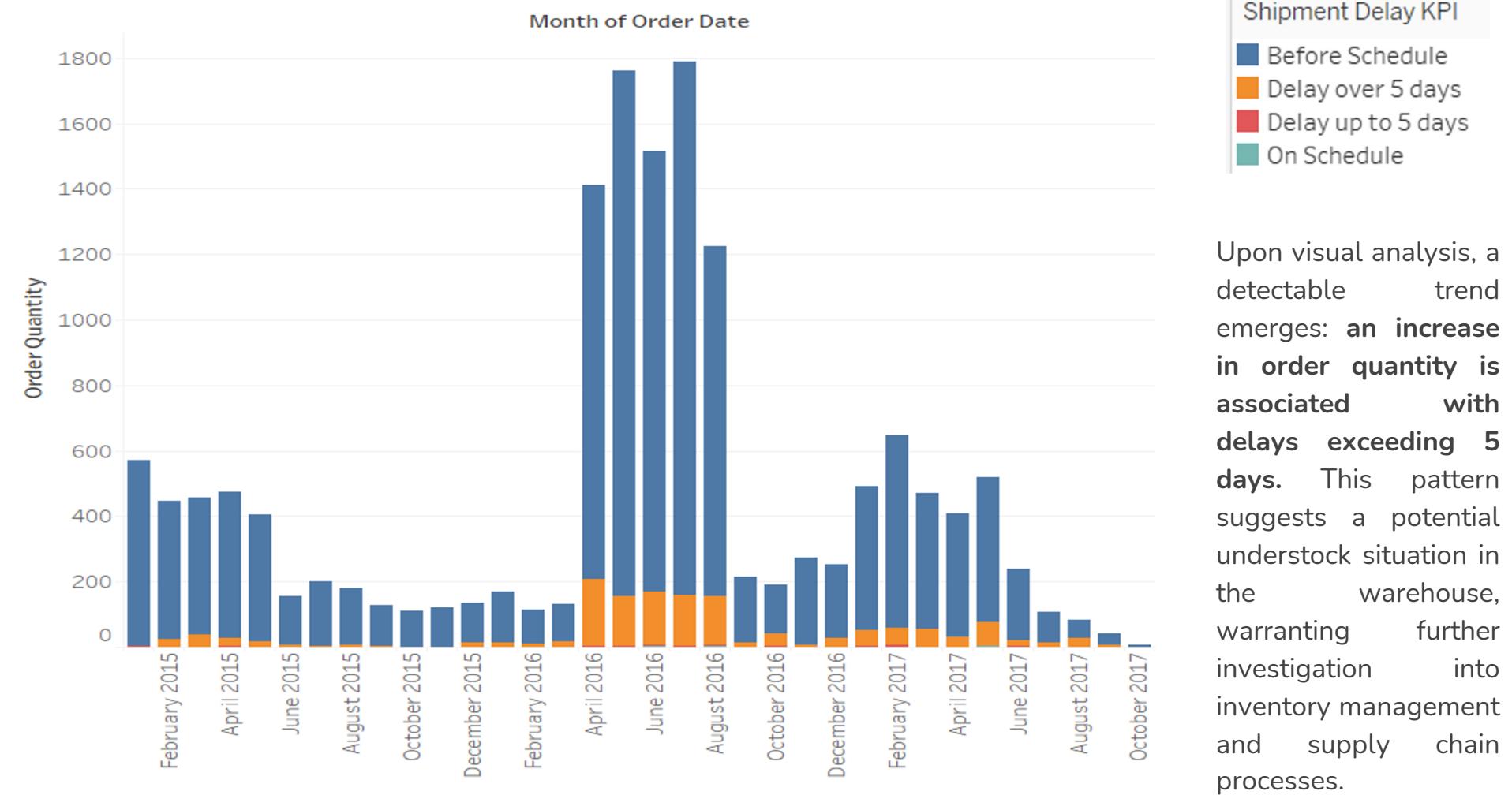


Order Quantity trend over Time



The graph exhibits a pronounced peak in July 2016, indicating a surge in order quantity to 1,789, amidst a fluctuating order trend over the observed period. The high order quantity near June 2016 is the area of our interest.

Shipment Delay Analysis



Thank You

