Supply Chain Analytics

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.

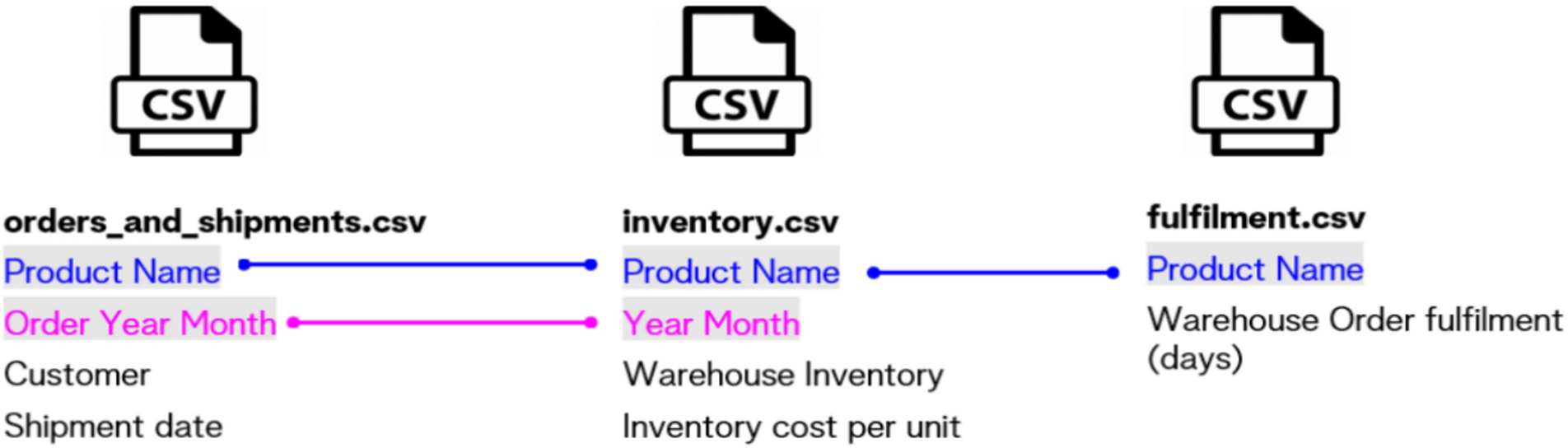
- The insights gained will be valuable for business stakeholders, offering a decision-making tool through final dashboards. Prompt identification and resolution of supply chain inefficiencies are facilitated, and strategic recommendations derived from the findings can substantially improve the overall 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



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

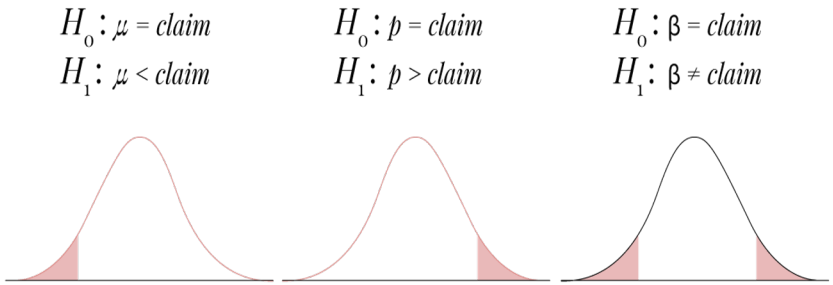
Geographical focus on the USA, Canada, and Mexico enables tailored recommendations based on each market's unique characteristics.

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 <= Mean profit earned from Women Apparels
- H(1): Mean profit earned from Cleats > Mean profit earned from Women's Apparels

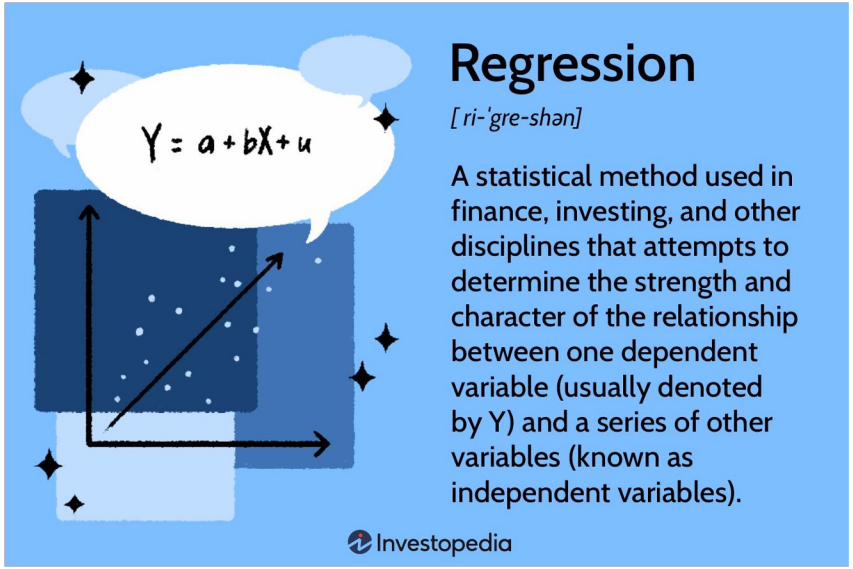
This statistical approach ensures the robustness of our findings and supports data-driven decision-making.



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.

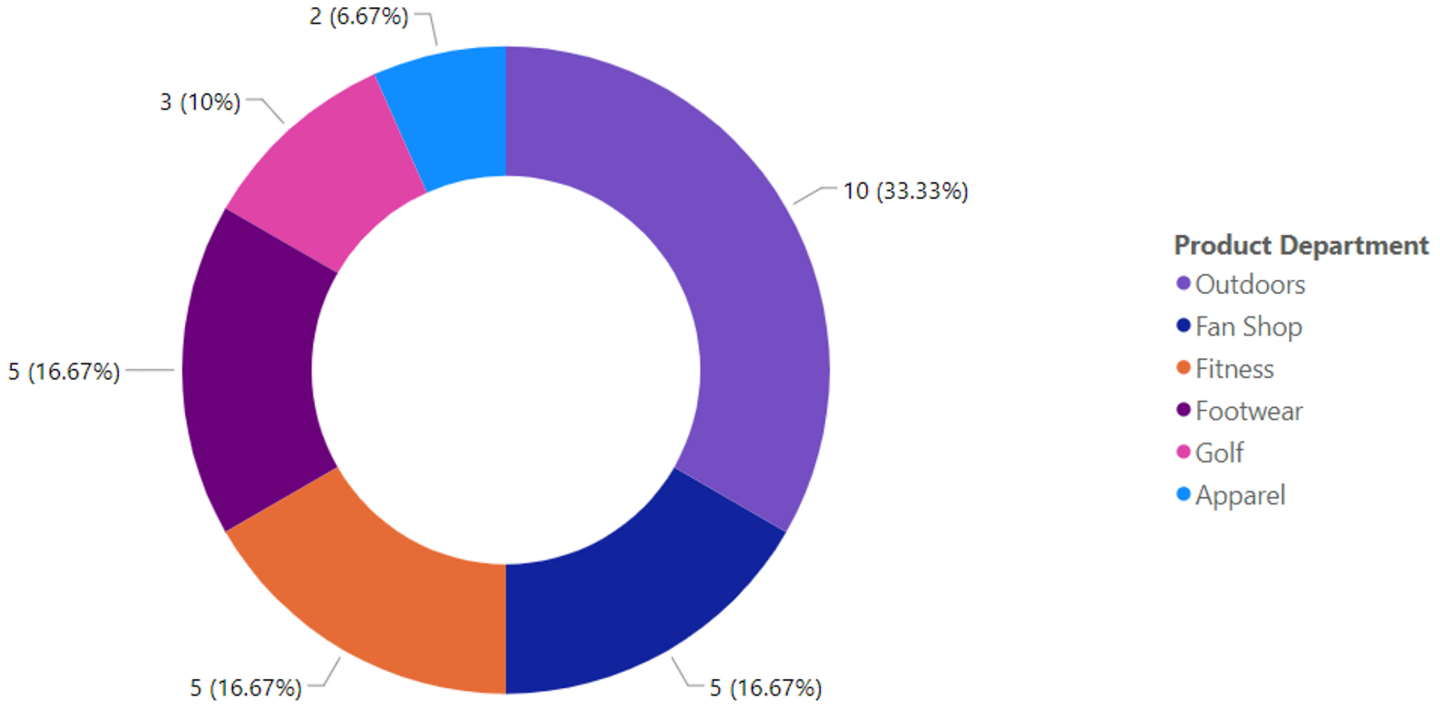
Shipment Analysis- focused on highlighting delayed orders and average delay times.

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

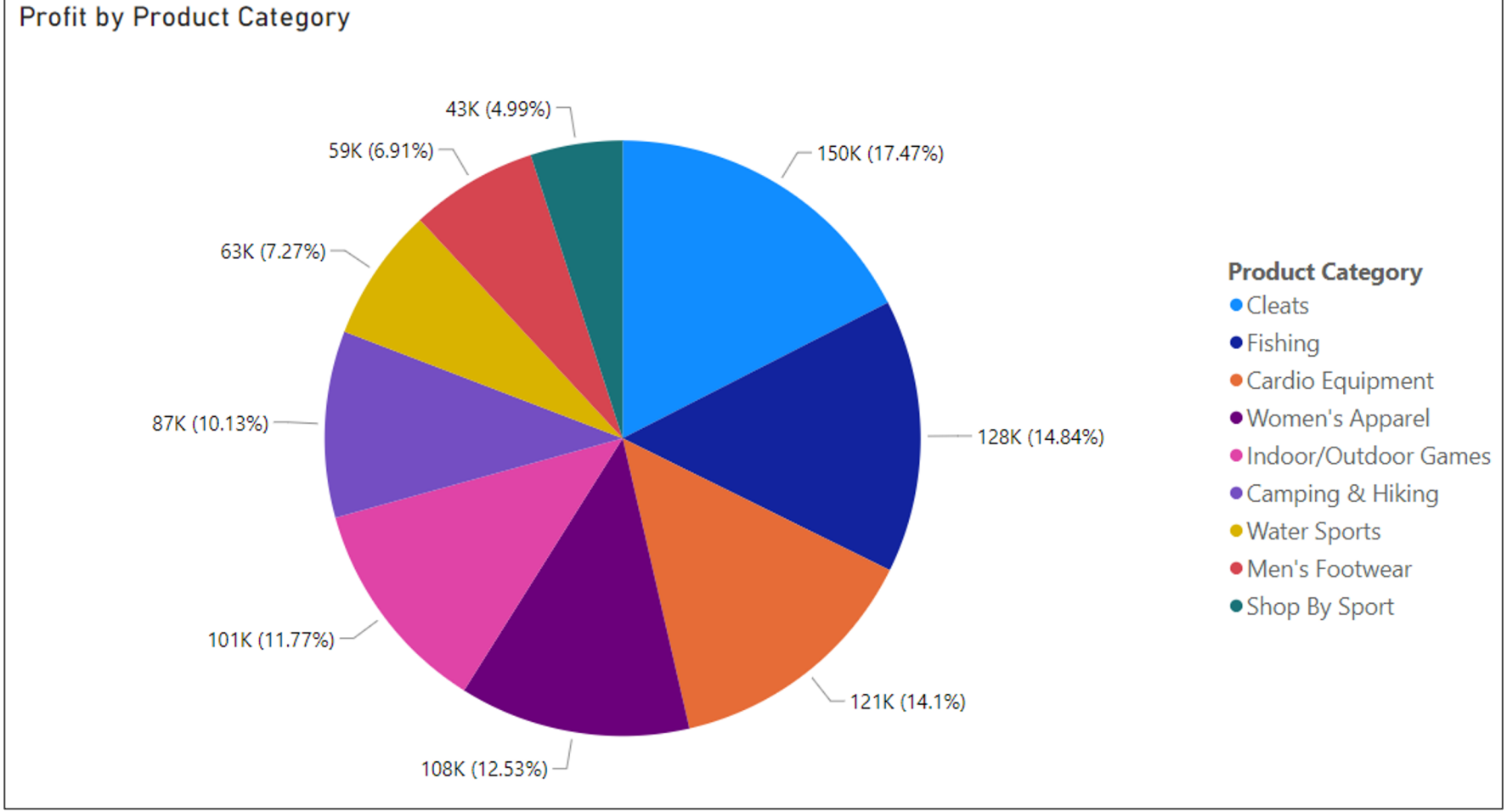
These dashboards serve as intuitive tools for stakeholders to glean actionable insights from the data.

Exploratory Visualizations

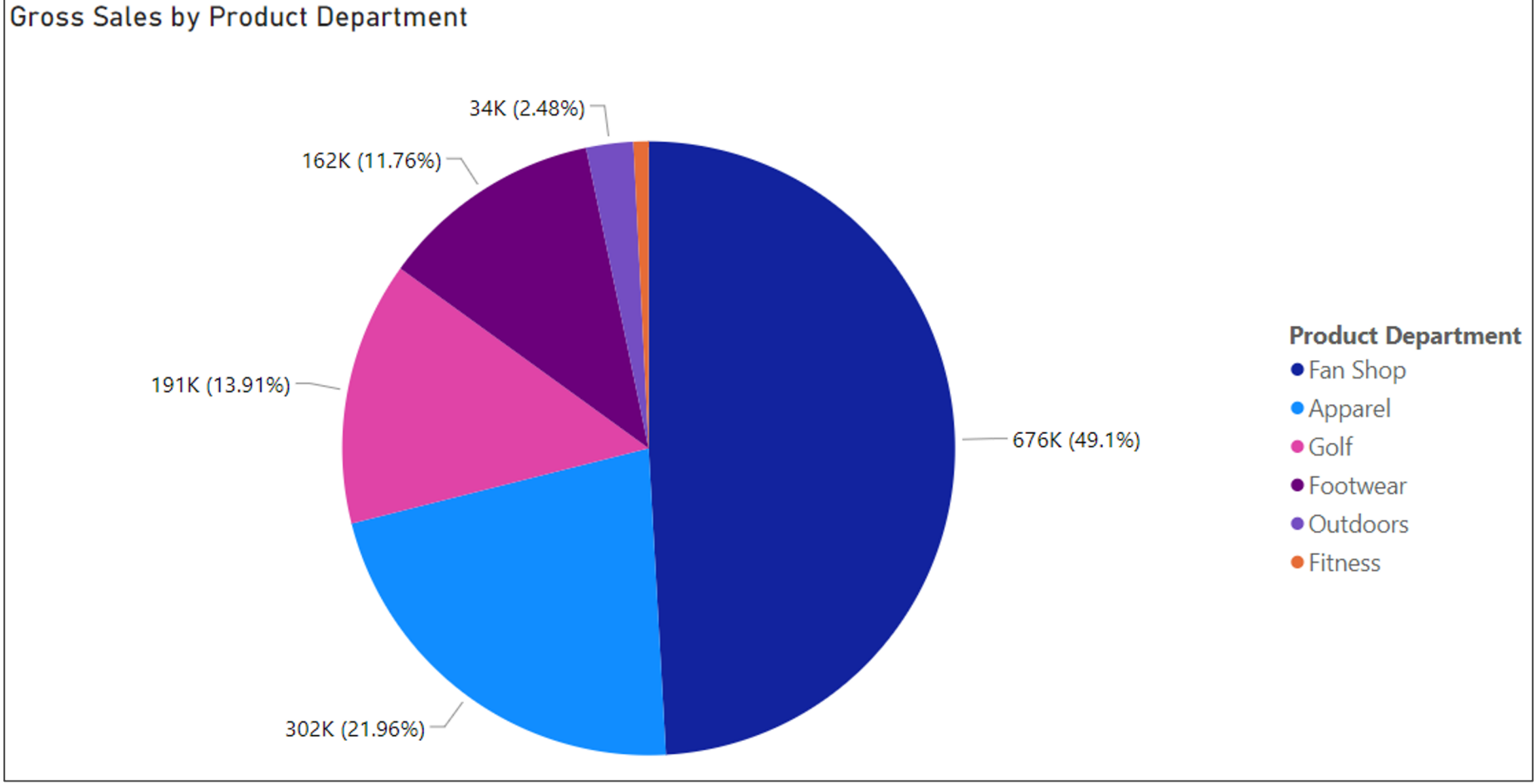
Count of Product Category by Product Department



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%.

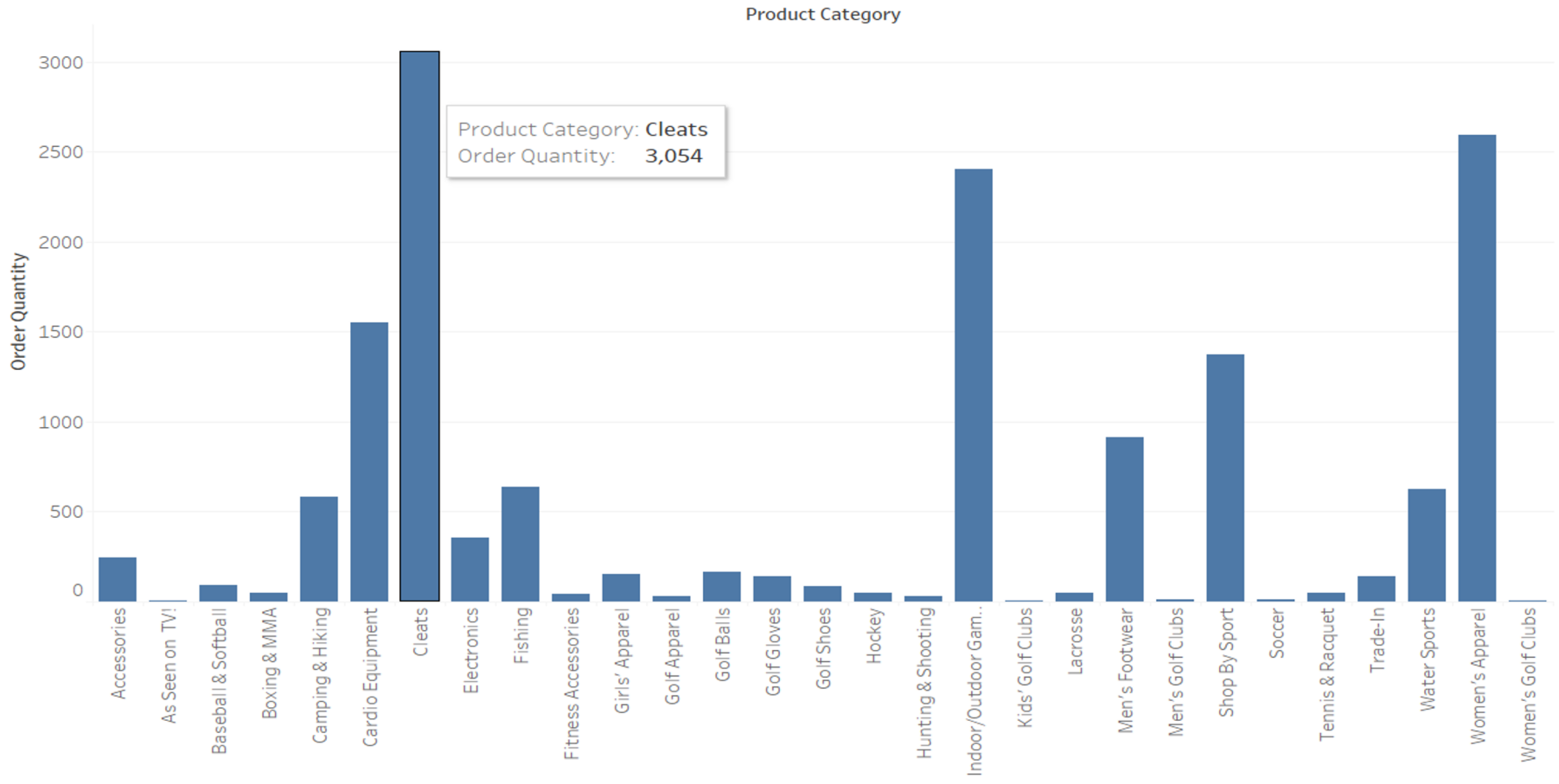


The pie chart depicts the profit distribution of product category gaining profits above $42K, with Cleats being the most profitable at 150K (17.47%)

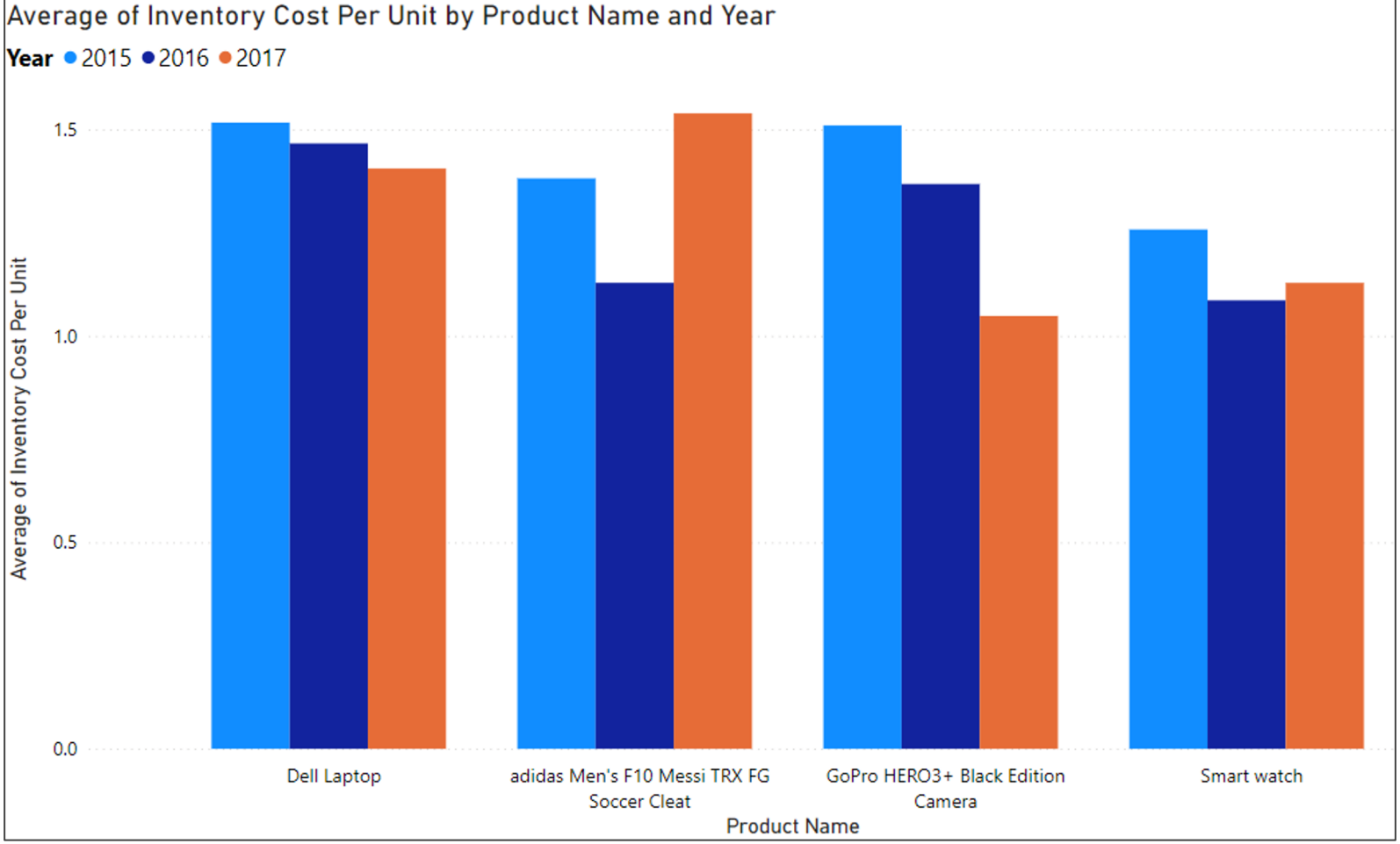


The pie chart depicts the Gross Sales per Product Department, with Fan Shop sharing approx 50% of the sales and Fitness with the least contribution.

Top Selling Categories

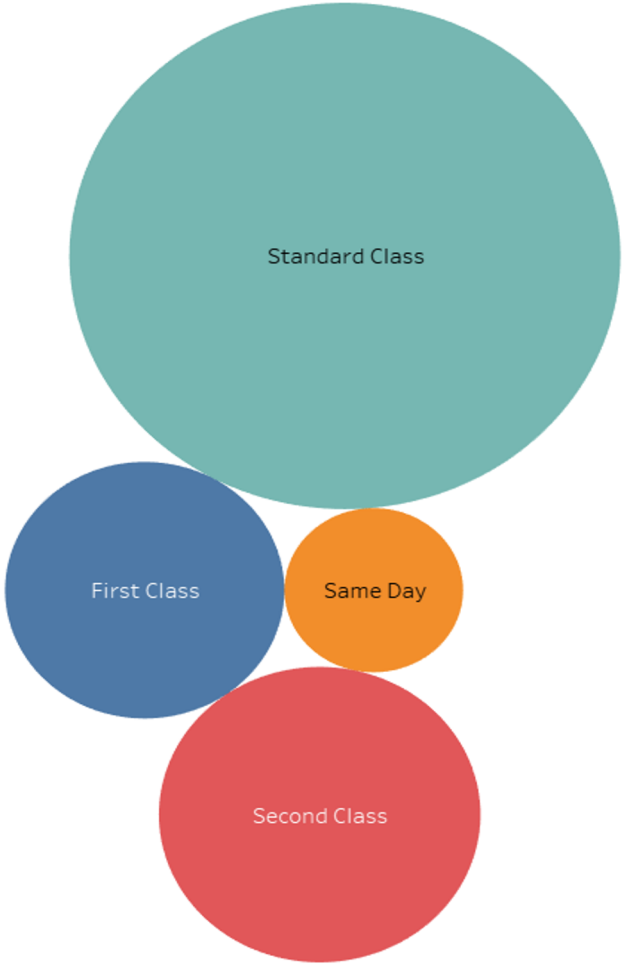


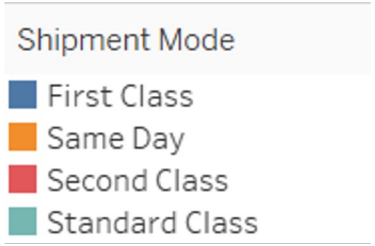
Cleats and Women's Apparel are top 2 selling categories based on the Order Quantity.



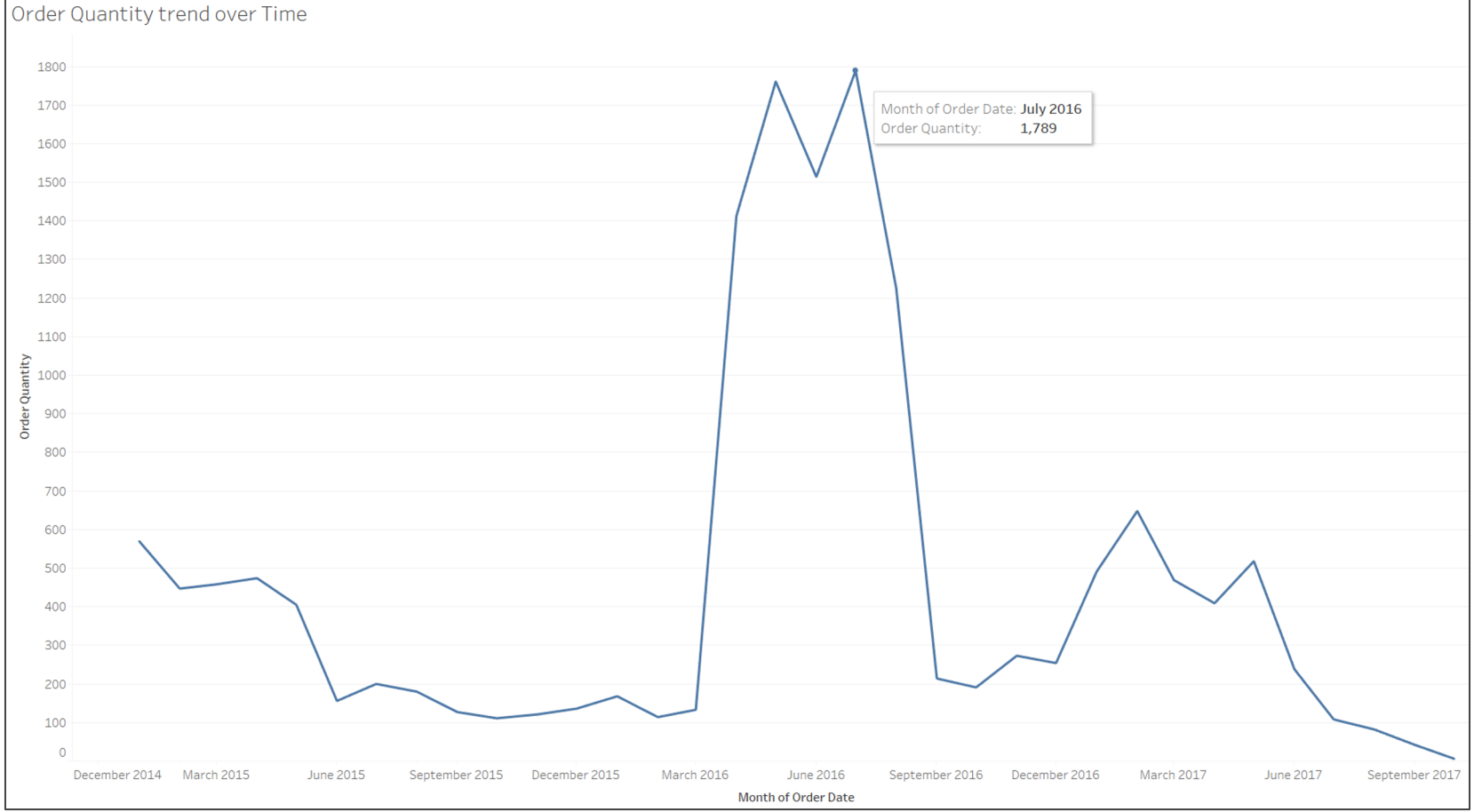
The bar chart compares the average inventory cost per unit of five products over three years, showing inventory cost trends for each product from 2015 to 2017.

Bubble chart for Profit earned from each Shipment Mode



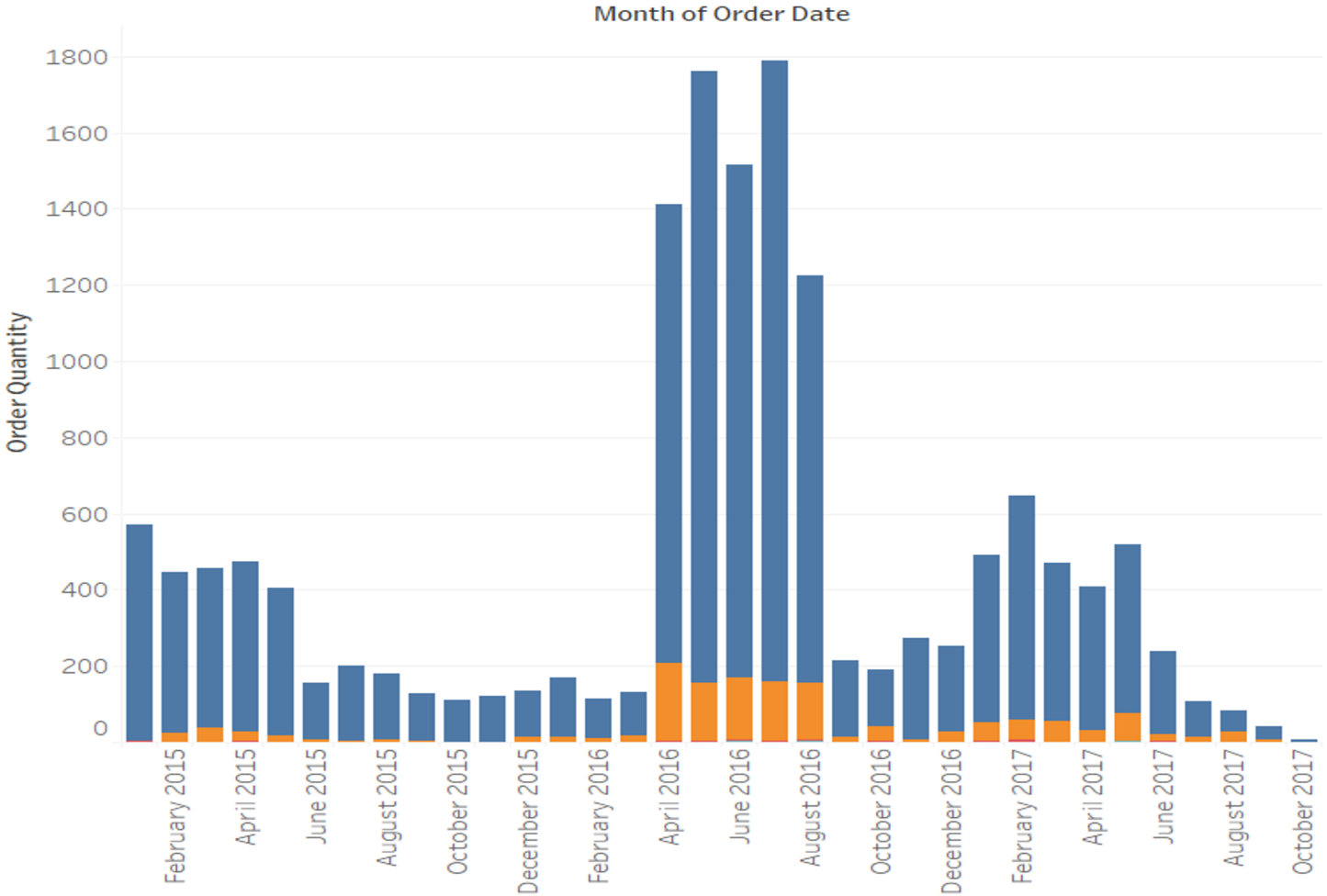


The bubble chart illustrates the relative profit contributions of different shipping modes, with larger bubbles representing greater profits. Maximum profit is earned from Standard Class.



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 are of our interest.

Shipment Delay Analysis



Upon visual analysis, a detectable trend emerges: **an increase in order quantity is associated with delays exceeding 5 days.** This pattern suggests a potential understock situation in the warehouse, warranting further investigation into inventory management and supply chain processes.

Thank You